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POST-OPERATIONAL FUEL STORAGE AREA GROUNDWATER QUALITY STUDIES 1983 THUNDER BAY TGS EXTENSION

Report No 84-103-K

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ABSTRACT

Data on the physical and chemical characteristics of groundwaters from the fuel storage areas at Thunder Bay TGS, for 1983, are presented in this report. In general, the 1983 data on the groundwater quality are similar to those acquired in the past. The high iron and sulphate concentrations that were found in 1982 in waters from piezometers around the lignite coal pile, on both sides of the drainage ditch, were also observed in the 1983 data but they were at slightly lower levels. Because of continuing inconsistent pH, sulphate and iron levels in waters on both sides of the drainage ditches, no conclusion can be reached yet on the effect of the ditches on groundwater quality. A longer period of time might be required for soil conditions and water quality to stabilize. Further monitoring appears to be required before any effect of the drainage ditches on groundwater quality will be evident. A more detailed review of all data from 1979 through 1984 will be conducted for the 1984 summary report.

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POST-OPERATIONAL FUEL STORAGE AREA
GROUNDWATER QUALITY STUDIES - 1983
THUNDER BAY TGS EXTENSION

INTRODUCTION

A survey of groundwater quality in the vicinities of the bituminous and the lignite coal piles, at Thunder Bay TGS Extension (TBTGS), was conducted during 1983. This survey is a continuation of the 'pre-operational' groundwater surveys conducted by London Monenco Consultants (LMC) during 1979/1/, and by Ontario Hydro during 1980-81/2,3/ and the 'post-operational' survey conducted by Ontario Hydro during 1982/4/. Due to manpower and budgetary restraints, the 1983 survey is a reduced program. The 1983 data on groundwater quality are summarized in this report.

The purpose of the 'pre-operational' surveys, 1979 through 1981, was to obtain baseline data on the local hydrology and on groundwater quality. The purpose of the 'post-operational' surveys, 1982 through 1984, is to provide data on groundwater quality for design verification purposes and evaluation of environmental impacts due to:

(i) the placement of a lignite coal storage pile, the coal transfer activities north of the plant, and the continued behaviour of the bituminous coal pile,

(ii) the construction of drainage ditches along the perimeters of the lignite coal storage area and the bituminous coal pile, as shown in Figure 1, and the collection and holding in a pond surface run-off to minimize infiltration of leachate to the groundwater,

and help identify any changes in groundwater quality.

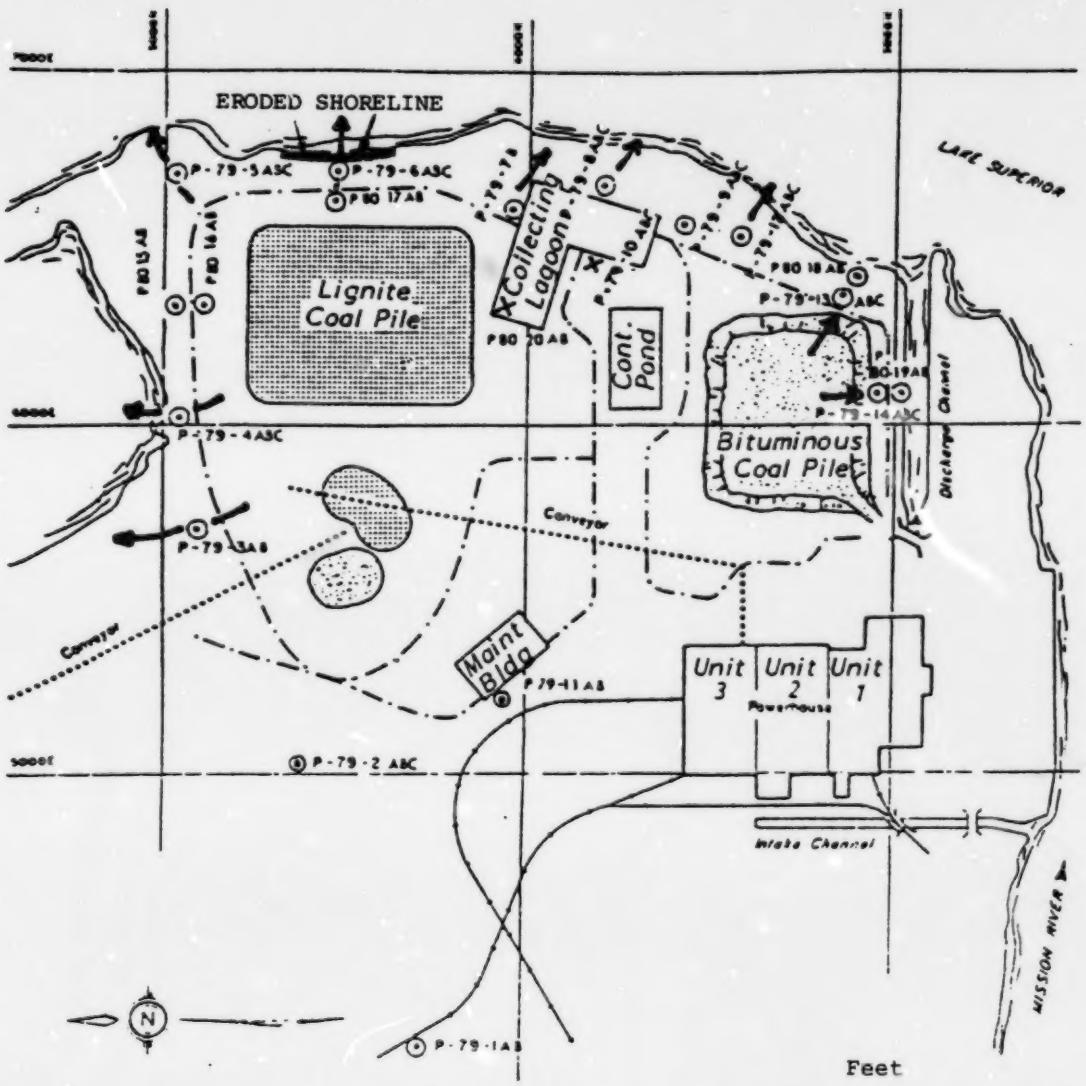

FIGURE 1

PIEZOMETER, PONDS, DITCHES
AND FUEL STORAGE LOCATIONS
THUNDER BAY TGS EXTENSION
1983

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These 'pre-operational' and 'post-operational' surveys were conducted at the request of Ontario Hydro's Environmental Studies and Assessments Department on behalf of the Thunder Bay Project.

HISTORY OF THE FUEL STORAGE AREA - TO END OF 1983

The following is a brief outline of the main events in the history of the 'Fuel Storage Areas' shown in Figure 1.

1) The coal pile for Unit #1 (sub-bituminous coal) has existed since the 1950's.

2) Lignite coal for Units #2 and #3 has been stockpiled in the 'lignite storage area' since late 1980. New lignite was stockpiled beginning in early 1981.

3) Ditches to intercept coal pile drainage (Figure 1) were completed in November 1981.

4) Significant erosion of the shoreline (~90 m) in the vicinity of piezometer nest 6 occurred in 1983 (see Figure 1). The eroded shoreline is about 1 m away from piezometer nest 6 and about 6 m from the drainage ditch. Piezometer nest 5 is also expected to be similarly affected, possibly in 1984. Initial shoreline stabilization was completed on November 14, 1983.

METHODOLOGY

The procedures used to obtain the data needed to characterize the hydrology and the quality of the run-off and the natural groundwater in the coal storage areas were similar to those used previously, with the following exceptions:

a) Piezometer level measurements were made in the spring only rather than in the spring and fall.

b) Groundwater levels were measured on six occasions only, between May and October, rather than at monthly intervals throughout the year.

1. Piezometer and Groundwater Level Surveys

Measurements of piezometer elevations were conducted by Civil Research in May. Groundwater levels were measured in May (twice), June, July, September and October by TBTGS personnel. Both sets of measurements are reported as elevations relative to the average Lake Superior shoreline level of 182.88 m (600 ft) for the Thunder Bay area.

2. Groundwater Sampling

Groundwater sampling by station personnel was scheduled for May, June and August to provide data representing both wet and dry season conditions. In general, the following water level measurement and sampling procedures were followed:

(a) Bailing
- Groundwater levels in each piezometer were measured and recorded. The water from each piezometer was bailed out with a hand-operated pump or a vacuum pump.
- Four days later the water from each piezometer was bailed out again.

(b) Sampling
- One day after the second bailing 1 L of groundwater from each piezometer was collected into an acid cleaned LPE bottle.
- The water's pH and conductivity were measured immediately with portable pH and conductivity meters.

(c) Preparation
- All samples collected were kept in a refrigerator at about 4°C.
- The samples were filtered as soon as possible using 0.45 µm prewashed membrane filters.
- A pretreated 500 mL LPE bottle was filled with the filtrate to which were added 2.5 mL of "ULTREX" HNO_3.
- A portion of the remaining filtrate was used for selected field tests.

(d) Shipping
- The remaining filtrate (from c) was kept at about 4°C in a cooler with ice packs, and shipped, together with the acidified samples, to Research Division by Air Express for analysis.

3. Groundwater Tests and Analysis

(a) Partial Analysis at TBTGS

The characteristics determined were pH, conductivity, acidity and alkalinity.

(b) Comprehensive Analysis - Research Division

Comprehensive chemical analyses of the groundwater samples were carried out by the Research Division. The characteristics determined are shown below:

pH	PO_4*	Ba	Mn	Ni
Conductivity, mS/m	F	Al	V	Sn
Alkalinity	Ca	Si	Cr	Zn
Acidity	Mg	Th	Cu	As
SO_4	Na	Be	Mo	B
Cl	K	Fe	Ag	Pb
NO_3	Sr	Ti	Co	Se
			Hg	Cd

* The 'soluble reactive phosphorus' present in filtered sample.

(c) Analytical Methods

The analytical methods used were mainly those outlined in the Standard Methods for the Examination of Water and Wastewater, published by the American Public Health Association (14th Edition). Ion chromatography, neutron activation and other instrumental techniques, currently in general use by the Analytic Section, were also used for some determinations.

4. Rationale

(a) Field Tests

Because some characteristics of natural waters change after sampling, pH and conductivity were measured in the field on fresh samples, and acidity and alkalinity were determined somewhat later in the station's laboratory.

(b) Comprehensive and Partial Analyses

Because of their complexity and time required, comprehensive and partial analyses were carried out by the Analytic Section of the Chemical Research Department, Research Division.

(c) Parameter Significance

Of the parameters determined, pH, conductivity, acidity, alkalinity and concentrations of SO_4 and Fe are considered as the main indicators of coal leachates. These parameters can be used to distinguish between normal and contaminated groundwaters.

The above indicators can be used to identify both the bituminous and the lignite coal leachates. However, the two types of leachates differ in their acidity and alkalinity levels. Leachates from bituminous coal are usually very acidic (low pH and low alkalinities). Leachates from freshly stockpiled lignite coal are usually alkaline (pH > 7 and low acidity)/3/.

Sulphate is regarded to be the most reliable indicator of the presence of bituminous and lignite coal leachates. High iron concentrations and low pH levels (high acidity and low alkalinity) are also indicative of bituminous coal leachate but they are more prone to modification on passage through the soil. The remaining parameters are less reliable contaminant indicators but do help in general characterization of water quality.

The major contaminant indicators discussed above and other selected analytical data, including trace metals, that will be obtained next year on the groundwater characteristics, will be examined in greater detail in the 1984 summary report to identify any changes that can be attributed to coal leachate seepage into the natural groundwater in the fuel storage areas.

RESULTS OF FIELD AND LABORATORY WORK CONDUCTED IN 1983

1. Piezometer Network Level Surveys

Piezometer elevation surveys were carried out by the Civil Research Department on May 18, 1983. The 1983 results, together with those obtained from 1979 to 1982, are summarized in Table I. Locations of the piezometers are shown in Figure 1.

2. Groundwater Level Surveys

Measurements of groundwater levels in piezometers on the perimeters of the fuel piles were carried out on six occasions during 1983. The results are shown in Table II.

Lake Superior water levels (daily and monthly means) for 1983, obtained from Fisheries & Oceans, Ottawa, for location Station 10050 in the Thunder Bay harbour, are shown in Table III.

TABLE I

FUEL STORAGE AREA - GROUNDWATER QUALITY STUDIES - 1983
THUNDER BAY TGS EXTENSION

PIEZOMETER REFERENCE LEVELS
(1979-1983)

Piezometer Identification		Piezometer Reference Levels, m (Relative to Average Shoreline Level of 182.68 m)												
		Date Surveyed												
		(1) 1979	(1)(2) 1980	July 16/81	Δ	Nov 2/81	Δ	June 9/82	Δ	Nov 3/82	Δ	May 18/83	Δ	Δ'
P79	1A	2.76	2.77	-	-	-	-	-	-	-	-	-	-	-
	1B	2.72	2.73	-	-	-	-	-	-	-	-	-	-	-
P79	2A	3.13	3.14	-	-	-	-	-	-	-	-	3.14	0.00	0.00
	2B	3.14	3.15	-	-	-	-	-	-	-	-	3.14	-0.01	-0.01
	2C	3.13	3.14	-	-	-	-	-	-	-	-	3.13	-0.01	-0.01
P79	3A	1.80	1.81	-	-	-	-	-	-	-	-	2.06	0.25	0.25
	3B	1.87	1.88	-	-	-	-	-	-	-	-	2.07	0.19	0.19
P79	4A	3.00	3.01	2.99	-0.02	3.05	0.06	3.01	-0.04	3.00	-0.01	3.01	0.01	0.00
	4B	2.98	2.99	2.94	-0.05	3.01	0.07	2.97	-0.04	2.95	-0.02	2.96	0.01	-0.03
	4C	3.02	3.03	2.97	-0.06	3.04	0.07	2.99	-0.05	2.98	-0.01	2.99	0.01	-0.04
P79	5A	3.50	3.51	3.42	-0.09	3.55	0.13	3.53	-0.02	3.52	-0.01	3.56	0.04	0.05
	5B	3.55	3.56	3.48	-0.08	3.61	0.13	3.59	-0.02	3.58	-0.01	3.62	0.04	0.06
	5C	3.61	3.62	3.52	-0.10	3.65	0.13	3.62	-0.03	3.46	-0.16	3.64	0.18	0.02
P79	6A	3.18	3.19	3.17	-0.02	3.30	0.13	3.29	-0.01	3.28	-0.01	3.30	0.02	0.11
	6B	2.96	2.97	3.00	0.03	3.14	0.14	3.15	0.01	3.14	-0.01	3.21	0.07	0.24
	6C	2.75	2.76	2.73	-0.03	2.87	0.14	2.87	0.00	2.86	-0.01	2.90	0.04	0.14
P79	7A	2.39	2.40	2.42	0.02	2.42	0.00	2.41	-0.01	2.41	0.00	2.40	-0.01	0.00
	7B	2.73	2.73	2.72	-0.01	2.74	0.02	2.72	-0.02	2.71	-0.01	2.71	0.00	-0.02
	7C	2.89	2.90	2.93	0.03	2.93	0.00	2.91	-0.02	2.70	-0.21	2.90	0.20	0.00
P79	8A	2.41	2.42	2.42	0.00	2.46	0.04	2.45	-0.01	2.44	-0.01	2.44	0.00	0.02
	8B	2.63	2.64	2.65	0.01	2.68	0.03	2.66	-0.02	2.65	-0.01	2.65	0.00	0.01
	8C	2.57	2.58	2.58	0.00	2.64	0.06	2.63	-0.01	2.63	0.00	2.63	0.00	0.05
P79	9A	2.10	2.11	2.38	0.27	2.37	-0.01	2.46	0.09	2.45	-0.01	2.50	0.05	0.39
	9B	2.09	2.10	2.43	0.33	2.43	0.00	2.53	0.10	2.44	-0.09	2.53	0.09	0.43
	9C	2.11	-	2.70	-	2.39	-0.31	2.49	0.10	2.48	-0.01	2.58	0.10	0.47
P79	10A	2.55	2.50	-	-	-	-	-	-	-	-	-	-	-
	10B	2.64	2.66	-	-	-	-	-	-	-	-	-	-	-
	10C	2.66	2.66	-	-	-	-	-	-	-	-	-	-	-
P79	11A	2.90	2.91	-	-	-	-	-	-	-	-	2.91	0.00	0.00
	11B	2.90	2.91	-	-	-	-	-	-	-	-	2.91	0.00	0.00
P79	12A	1.78	1.79	2.19	0.40	2.05	-0.14	2.08	0.03	2.07	-0.01	2.11	0.04	0.32
	12B	1.83	1.84	2.18	0.34	2.15	-0.03	2.19	0.04	2.19	0.00	2.30	0.11	0.46
	12C	1.88	1.89	2.08	0.19	2.17	0.09	2.18	0.01	2.17	-0.01	2.24	0.07	0.35
P79	13A	2.06	2.06	2.16	0.10	2.13	-0.03	2.17	0.04	2.16	-0.01	2.18	0.02	0.12
	13B	2.03	2.04	2.17	0.13	2.14	-0.03	2.15	0.01	1.94	-0.21	2.16	0.22	0.12
	13C	2.03	2.02	2.22	0.20	2.19	0.03	2.19	0.00	2.19	0.00	2.22	0.03	0.20
P79	14A	2.25	2.26	2.33	0.07	2.33	0.00	2.35	0.02	2.33	-0.02	2.33	0.00	0.07
	14B	2.20	2.21	2.34	0.13	2.30	-0.04	2.35	0.05	2.34	-0.01	2.35	0.01	0.14
	14C	2.25	2.25	2.37	0.12	2.29	-0.08	2.29	0.00	2.28	-0.01	2.27	-0.01	0.02
P80	15A	-	3.60	3.47	-0.13	3.58	0.11	3.54	-0.04	3.53	-0.01	3.57	0.04	-0.03
	15B	-	3.56	3.51	-0.05	3.61	0.10	3.58	-0.03	3.57	-0.01	3.61	0.04	0.05
P80	16A	-	3.38	3.26	-0.12	3.36	0.10	3.37	0.01	3.36	-0.01	3.41	0.05	0.03
	16B	-	3.31	3.34	0.03	3.43	0.09	3.45	0.02	3.44	-0.01	3.51	0.07	0.20
P80	17A	-	3.35	2.87	-0.48	3.01	0.14	3.02	0.01	3.01	-0.01	3.08	0.07	-0.27
	17B	-	2.95	3.28	0.33	3.41	0.13	3.42	0.01	3.42	0.00	3.48	0.06	0.53
P80	18A	-	2.17	2.25	0.08	2.21	-0.04	2.21	0.00	2.21	0.00	2.22	0.01	0.05
	18B	-	2.17	2.24	0.07	2.20	-0.04	2.19	-0.01	2.18	-0.01	2.21	0.03	0.04
P80	19A	-	2.27	2.31	0.04	2.27	-0.04	2.24	-0.03	2.22	-0.02	2.21	-0.01	-0.06
	19B	-	2.66	2.70	0.04	2.66	-0.04	2.62	-0.04	2.61	-0.01	2.59	-0.02	-0.07
P80	20A	-	2.92	2.94	0.02	2.87	-0.07	-	-	-	-	-	-	-
	20B	-	2.54	2.55	0.01	3.14	0.59	-	-	-	-	-	-	-

(1) London Monenco Consultants Ltd., Baseline Report for Ontario Hydro Thunder Bay TGS Extension - Groundwater Monitoring Study - Coal Storage Area (B-2) Feb. 1980.

(2) Ontario Hydro data for 1980 from 15A to 20B. The remaining are rounded 1979 LMC data.

Δ Change from previous levels (m).

Δ' Change from the original or the 1980 levels (m)

TABLE II

FUEL STORAGE AREA - GROUNDWATER QUALITY STUDIES - 1983
THUNDER BAY TGS EXTENSION

RELATIVE PIEZOMETER AND LAKE WATER LEVELS - 1983
(Relative to Average Shoreline Level of 181.88 m)

Piezometer Identification	Relative Water Levels in Piezometers (m)					
	Dates Measurements Taken					
	May 5, 1983	May 31, 1983	June 24, 1983	July 26, 1983	Sept 20, 1983	Oct 28, 1983
P79 1A	1.33	1.33	1.22	1.11	1.18	1.24
P79 1B	1.24	1.30	1.20	1.10	1.17	1.24
P79 2A	-	-	-	-	-	--
P79 2B	-	-	-	-	-	--
P79 2C	-	-	-	-	-	--
P79 3A	0.83	-	0.68	0.51	0.60	0.69
P79 3B	0.85	-	0.69	0.53	0.61	0.72
P79 4A	0.80	0.54	0.48	0.46	0.44	0.53
P79 4B	0.49	-	0.48	0.45	0.46	0.54
P79 4C	0.49	-	0.49	0.45	0.44	0.53
P79 5A	0.31	-	0.41	0.42	0.40	0.49
P79 5B	0.37	-	0.42	0.43	0.41	0.45
P79 5C	0.37	0.40	0.41	0.42	0.43	0.44
P79 6A	0.29	-	0.38	0.40	0.38	--
P79 6B	0.33	0.39	0.40	0.41	0.40	0.41
P79 6C	0.31	0.46	0.37	0.39	0.38	--
P79 7A	-0.12	-	-0.15	-0.17	-0.14	0.09
P79 7B	-0.09	-0.13	-0.11	-0.13	-0.04	0.06
P79 7C	-0.04	-	-0.04	-0.07	0.01	0.10
P79 8A	-0.12	-	-0.13	-0.13	-0.04	0.04
P79 8B	-0.12	-0.13	-0.14	-0.11	-0.03	0.03
P79 8C	-0.04	-	-0.02	0.01	0.03	0.10
P79 9A	0.26	-	0.39	0.33	0.32	0.36
P79 9B	0.21	-	0.40	0.35	0.34	0.37
P79 9C	0.27	-	0.40	0.36	0.34	0.36
P79 10A	-	-	-	-	-	--
P79 10B	-	-	-	-	-	--
P79 10C	-	-	-	-	-	--
P79 11A	1.15	-	1.04	0.97	1.15	1.16
P79 11B	1.09	-	1.05	0.97	1.16	1.15
P79 12A	0.30	-	0.40	0.22	0.37	0.39
P79 12B	0.30	-	0.40	0.38	0.37	0.40
P79 12C	0.29	0.40	0.40	0.37	0.37	0.39
P79 13A	0.34	-	0.41	0.38	0.41	0.45
P79 13B	0.32	0.41	0.38	0.37	0.41	0.42
P79 13C	0.29	0.39	0.35	0.36	0.37	0.41
P79 14A	0.30	0.35	0.35	0.36	0.38	0.39
P79 14B	0.30	0.37	0.35	0.38	0.38	0.40
P79 14C	0.30	0.37	0.36	0.38	0.40	0.40
P80 15A	0.57	0.66	0.62	0.58	0.57	0.69
P80 15B	0.90	1.07	1.05	0.91	0.59	1.30
P80 16A	0.73	0.84	0.76	0.69	0.69	--
P80 16B	0.73	0.86	0.76	0.72	0.69	--
P80 17A	0.42	0.53	0.55	0.52	0.49	0.57
P80 17B	0.39	0.69	0.73	0.48	0.52	0.79
P80 18A	0.25	0.38	0.37	0.44	0.39	0.38
P80 18B	0.30	0.38	0.37	0.39	0.39	0.40
P80 19A	0.29	0.33	0.34	0.39	0.36	0.37
P80 19B	0.29	0.36	0.36	0.81	0.36	0.39
P80 20A	-	-	-	-	-	--
P80 20B	-	-	-	-	-	--
Lake Levels[1]	-	0.25	0.34	0.38	0.34	0.38

[1] Marine Environmental Data, Services Branch, Fisheries and Oceans, Ottawa. See Table III for detailed data.

DAILY MEAN LEVELS / MOYENNES JOURNALIERES DE NIVEAU D EAU

.STATION 10050 THUNDER BAY BAT

TIME ZONE EST

DAY	MONTH	YEAR	MONTHLY MEANS	DAILY MEANS											HIGH INSTANTANEOUS		LOW INSTANTANEOUS		
															DAY	TIME	HT	DAY	TIME	HT
1	10	1	83	(0.29)*	18320	18319	18321	18323	18319	18321	18317	18323	18326	18320						
11	20	1	83		18314	18320	18317	18317	18317	18319	18313	18315	18318	18318						
21	31	1	83	183172	18317	18316	18315	18313	18312	18312	18314	18317	18316	18312	18313	4	730	18333	26	2230	18307
1	10	2	83	(0.23)	18315	18310	18308	18312	18311	18311	18313	18311	18312	18314						
11	20	2	83		18314	18313	18314	18311	18311	18312	18309	18310	18312	18310						
21	28	2	83	183110	18310	18311	18309	18307	18308	18311	18310	18307				13	1115	18320	3	215	18300
1	10	3	83	(0.20)	18307	18308	18308	18309	18309	18309	18311	18309	18305	18308						
11	20	3	83		18310	18312	18312	18308	18309	18310	18309	18307	18305	18307						
21	31	3	83	183083	18307	18307	18307	18308	18309	18309	18306	18306	18308	18309	18309	6	1845	18318	9	200	18300
1	10	4	83	(0.21)	18307	18305	18304	18305	18306	18306	18305	18307	18306	18306						
11	20	4	83		18306	18307	18309	18307	18310	18310	18310	18310	18311	18311						
21	30	4	83	183087	18310	18310	18310	18311	18312	18312	18312	18312	18312	18312		26	1815	18323	14	015	18294
1	10	5	83	(0.25)	18312	18310	18313	18311	18314	18312	18310	18312	18312	18313						
11	20	5	83		18313	18313	18316	18311	18311	18313	18314	18314	18312	18312						
21	31	5	83	183131	18314	18313	18313	18315	18313	18314	18315	18315	18314	18315	18318	30	1845	18322	2	645	18301
1	10	6	83	(0.34)	18319	18320	18320	18320	18321	18321	18322	18322	18322	18322						
11	20	6	83		18324	18323	18323	18324	18324	18324	18323	18322	18322	18323						
21	30	6	83	183224	18323	18325	18323	18322	18325	18321	18321	18322	18322	18326		22	1845	18338	26	2000	18311
1	10	7	83	(0.38)	18324	18323	18328	18324	18326	18328	18329	18327	18327	18328						
11	20	7	83		18329	18328	18328	18328	18327	18327	18327	18327	18326	18326						
21	31	7	83	183262	18325	18327	18325	18324	18325	18325	18326	18326	18324	18324	18325	4	730	18350	3	2315	18288
1	10	8	83	(0.36)	18323	18324	18325	18325	18326	18324	18326	18322	18324	18326						
11	20	8	83		18325	18326	18326	18324	18325	18324	18324	18325	18325	18323						
21	31	8	83	183243	18325	18323	18324	18324	18325	18324	18324	18324	18324	18323	18323	19	1445	18340	19	1315	18310
1	10	9	83	(0.34)	18324	18324	18324	18323	18323	18322	18322	18324	18323	18323						
11	20	9	83		18323	18322	18322	18322	18323	18322	18325	18324	18322	18321						
21	30	9	83	183221	18320	18318	18320	18322	18320	18320	18320	18322	18320	18321		10	1315	18349	20	630	18306
1	10	10	83	(0.38)	18323	18319	18321	18323	18323	18319	18321	18322	18323	18325						
11	20	10	83		18324	18322	18323	18323	18331	18331	18328	18328	18330	18329						
21	31	10	83	183256	18329	18328	18328	18330	18327	18328	18330	18323	18327	18328	18328	16	245	18341	3	530	18303
1	10	11	83	(0.35)	18326	18320	18321	18322	18325	18323	18325	18321	18321	18321						
11	20	11	83		18321	18322	18324	18322	18320	18319	18320	18322	18322	18327						
21	30	11	83	183226	18321	18322	18321	18324	18323	18322	18326	18324	18322	18322		23	2315	18352	2	1945	18312
1	10	12	83	(0.29)	18323	18321	18325	18321	18319	18319	18322	18318	18319	18319						
11	20	12	83		18325	18318	18320	18318	18315	18317	18316	18315	18316	18316						
21	31	12	83	183174	18321	18315	18312	18308	18313	18315	18316	18312	18314	18316	18313	4	215	18330	24	1100	18304

* Lake water levels - the difference between the monthly means and the average shoreline level of 182.88 m

LAKE SUPERIOR WATER LEVELS - 1983

THUNDER BAY HARBOUR - STATION 10050

(Marine Environmental Data, Services Branch, Fisheries and Oceans, Ottawa)

TABLE III

3. Groundwater Characteristics

The detailed analytical results obtained at Thunder Bay TGS and at Research on groundwater samples taken on June 2, July 26 and September 21, 1983, are shown in Appendix A. The pH, alkalinity and conductivity data obtained at Thunder Bay TGS are also included in the summary. However, because they were obtained on the same samples that were submitted for the comprehensive analysis, the results are shown under a different date (one day after the actual sampling) to avoid computer problems in recalling the data in the future. The main groundwater characteristics are presented in Tables IV to IX and Figures 3 to 13 in the discussion section.

DISCUSSION

1. Piezometer Reference Levels

The piezometer reference levels for 1983, given in Table I, show that from November 3, 1982 to May 18, 1983, there was very little change in most piezometer levels. The greatest changes in elevations were increases of ∿20 cm of piezometers 5C and 7C on the east side of the lignite pile and piezometer 13B on the southeast corner of the bituminous coal pile. There were no significant decreases in piezometer levels.

Comparison of the original (1979-80) piezometer levels with the 1983 levels shows a few major changes in elevations. Levels for piezometers 3A, 3B, 6B, 9A, 9B, 9C, 12A, 12B, 12C, 13C, 16B and 17B increased by more than 20 cm. As these locations almost surround the two piles, the changes cannot be attributed to any local ground movements. Only one major decrease (27 cm) in elevations occurred for piezometer 17A on the east side of the lignite pile. This piezometer sank 48 cm in the first year after installation in 1980 after which it rose to the present level and appears to be stabilized.

2. Groundwater Levels

The piezometer water level data acquired in 1983 (Table II) show that groundwater levels in the fuel storage areas varied from a low of 0.17 m below the average shoreline level of 182.88 m (the reference level), in piezometer 7A on July 26, 1983, to a high of 1.33 m in piezometer 1A on May 5 and May 31, 1983.

As in 1982, low water levels were observed in piezometer nests 7 and 8 and high levels in piezometer nests 1, 11 and 15. The lowest groundwater levels exist in the area south and southeast of the lignite pile or at the northeastern corner of the collecting lagoon. The high groundwater levels exist in the areas north and inland and west of the lignite pile. These general water levels are similar to those observed in the previous years.

The relationship between groundwater levels in selected piezometers, lake levels and total precipitation*, shown in Figure 2, show that in general the groundwater levels rose somewhat during the spring thaw, remained relatively stable to the middle of June, dropped slightly in July, after which they rose again in September and October. The plot of total precipitation data shows a generally uniform precipitation condition between March and October thus indicating no significant effects on groundwater levels. As in previous years, the changes in groundwater levels again appear to be seasonal rather than influenced by lake water levels.

3. Groundwater Quality

The data on the chemical characteristics of the groundwaters sampled in 1983 are summarized in Appendix A. The major ion chemistry of the waters, illustrated by Piper diagrams and summarized by ion balances, is shown in Appendix B. The main characteristics of the groundwaters from locations around the lignite and the bituminous coal piles are discussed below.

(a) pH

A summary of the 1983 pH levels of the groundwaters from the fuel storage areas is shown in Table IV. Figure 3 shows a plot of pH levels in waters from six selected piezometers from 1979 through 1983.

The 1983 pH levels of the groundwaters in the fuel storage areas are almost all in the range between 5.8 and 6.9, except for the lower levels in the waters from piezometer 19B, when measured on fresh waters immediately after sampling. After filtering and transporting to the Research laboratory, the pH levels changed, some dropped as in piezometer nests 12, 13, 14, 18 and 19, and the remainder rose.

As discussed in the 1982 report (Ontario Hydro Research Division Report No 83-442-K) the differences in pH levels obtained at TBTGS on fresh unfiltered samples, and those obtained at Research on filtered and 'aged' samples, are probably due to measurement differences caused by the presence of soil particulates in the unfiltered samples and exposure of the samples to the atmosphere (oxygen) during filtration and storage. These pH differences will also likely be accompanied by differences between the field and laboratory values for acidity, alkalinity and conductivity. Because of these field and laboratory differences in water characteristics a distinction may have to be made in the waters' assessment between the groundwater's quality (pH, acidity, alkalinity and conductivity) while in the ground and while out of the ground.

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* See 'Total Daily Precipitation of Rain and Snow' in the Environment Canada Annual Meteorological Summary, for 1983, in Appendix C.

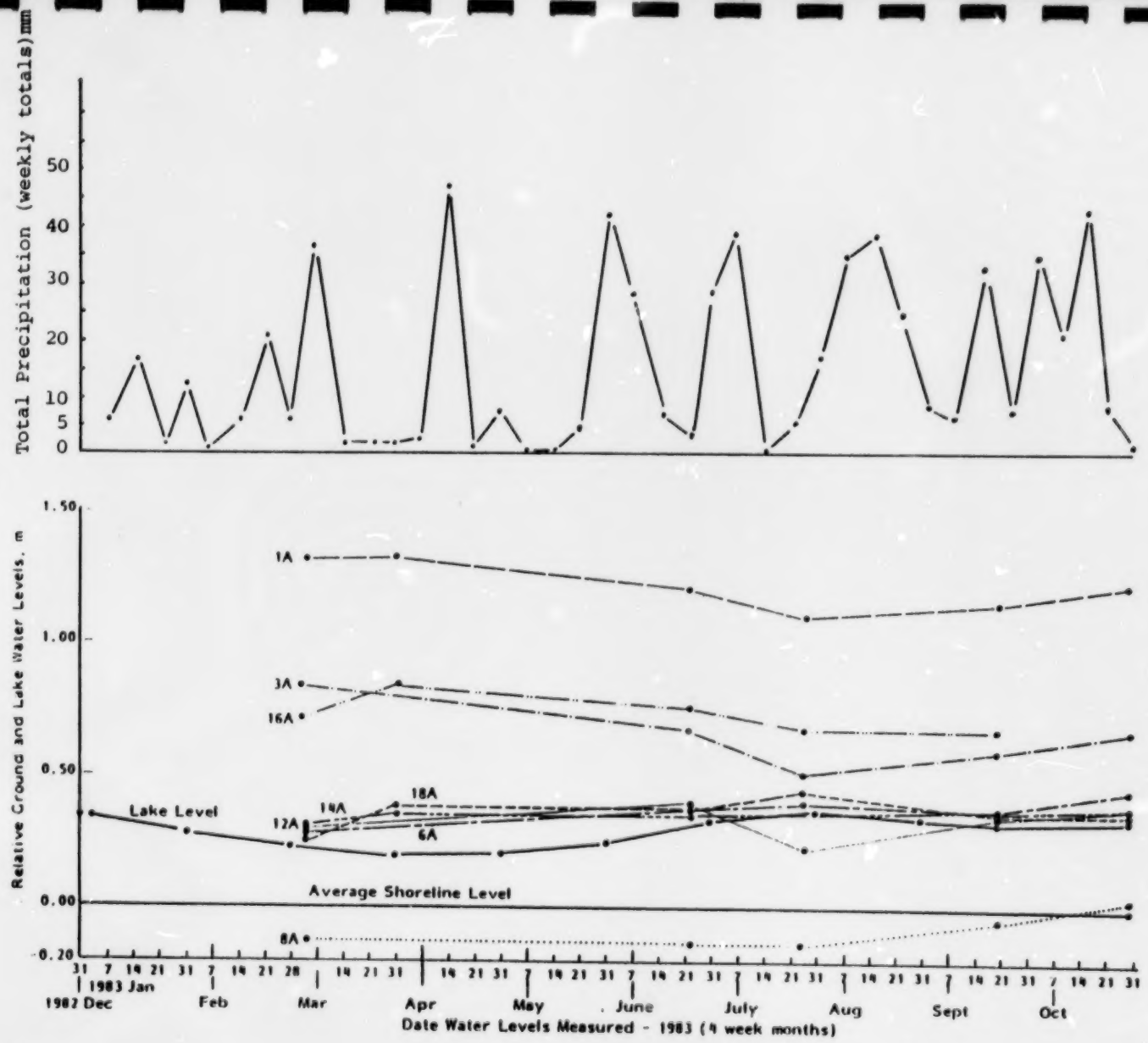


FIGURE 2

FUEL STORAGE AREA GROUND AND LAKE WATER LEVELS* - 1983

*(In m and relative to the average shoreline level of 182.88)

and Precipitation (mm)

TABLE IV

FUEL STORAGE AREA GROUNDWATER QUALITY
TBTGS - 1983

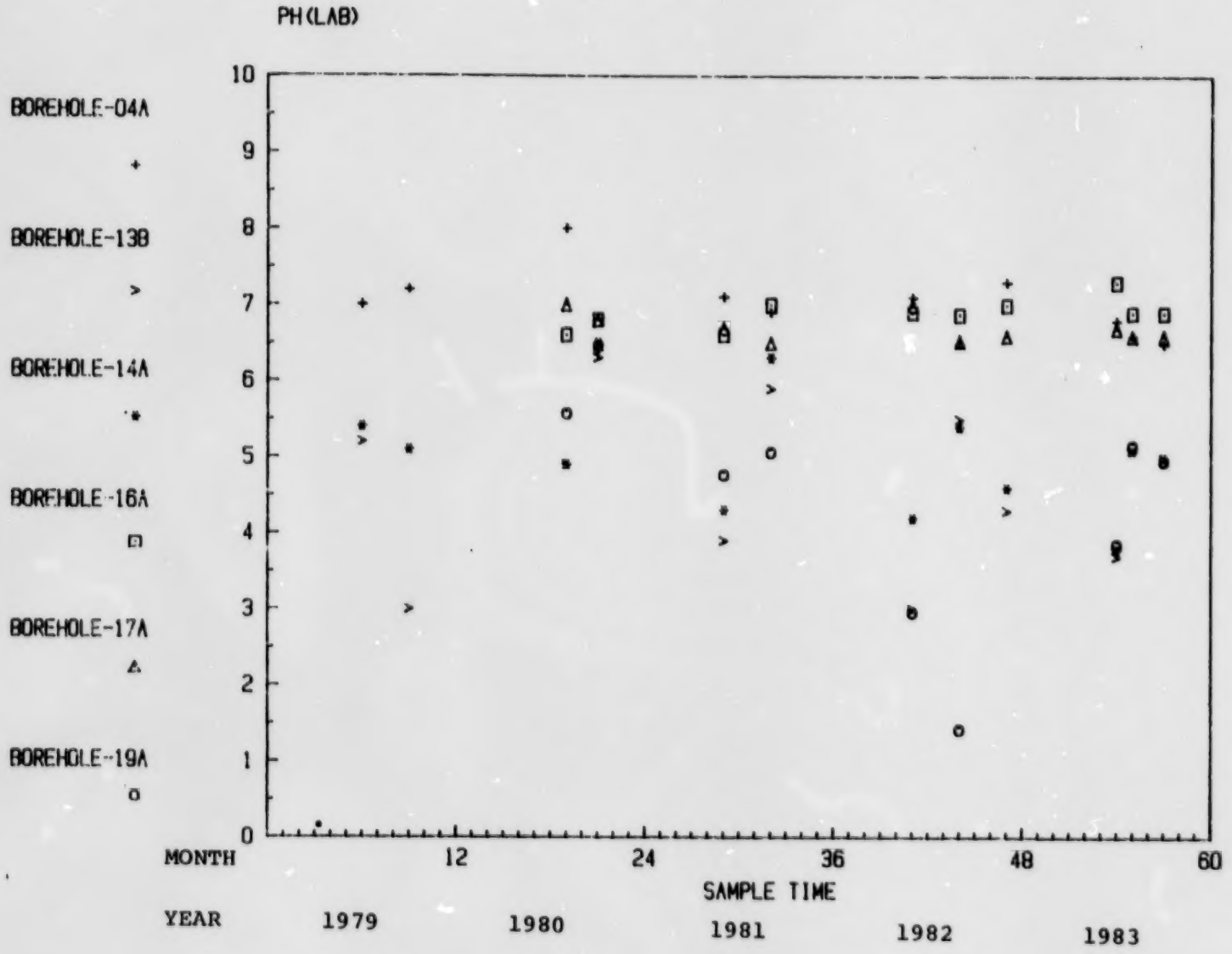
TEST: pH

Location	Sampling Date 830602	830603*	830726	830727*	830921	830922*
01A	7.4	6.1	7.2	6.5	7.2	6.4
03A	-	-	6.8	6.0	6.9	6.5
04A	6.8	6.6	6.6	6.7	6.5	6.5
05C	7.6	6.8	7.0	6.7	7.1	6.1
06B	7.5	6.8	7.0	6.9	7.3	5.9
06C	7.3	6.9	6.8	6.8	7.0	6.3
07B	7.6	6.6	7.2	6.4	7.4	6.5
08B	7.6	6.5	7.0	6.6	7.7	6.9
12C	4.3	6.2	5.4	6.5	5.8	5.8
13B	3.7	6.3	5.1	6.0	5.0	6.2
13C	3.8	6.4	5.2	6.1	5.0	6.2
14A	3.8	6.0	5.1	6.4	5.0	5.9
14B	3.8	6.2	5.7	6.2	5.6	6.2
14C	-	6.4	6.6	6.4	6.4	6.5
15A	7.2	6.4	6.8	6.8	6.7	6.5
15B	7.2	6.4	7.1	6.8	6.8	6.5
16A	7.3	6.7	6.9	6.7	6.9	6.5
16B	6.9	6.4	6.8	6.6	6.7	6.5
17A	6.7	6.2	6.6	6.5	6.6	6.3
17B	-	6.7	7.0	6.6	6.9	6.4
18A	4.0	6.3	5.5	6.2	5.2	6.2
18B	4.2	6.4	6.2	6.3	5.9	6.0
19A	3.9	6.0	5.2	6.4	5.0	6.1
19B	-	5.1	4.6	5.6	4.3	5.1

*TBTGS data on fresh samples taken the day before that shown. This is to avoid confusion in data input to computer, (see page 7).

FUEL CELL GROUNDWATER-TBTGS-1983

Fig. 3 PH(LAB) vs TIME



During 1983 the pH levels of the groundwaters tested at Research ranged from a low of 3.7 in piezometer 13B on June 2, to a high of 7.7 in piezometer 08B on September 21. As in 1982, waters of very low pH levels (4.3 or less) were present in piezometers 12C, 13B, 13C, 14A, 14B, 18A, 18B and 19A sampled in June. The pH levels in waters sampled in July and September were substantially higher. All of these piezometers are located on the east and south sides of the bituminous coal pile. Waters of higher pH levels (>6) were present in the remaining piezometers, all located north and west of the two coal piles. This is consistent with pH levels obtained in the previous years.

Comparison of the 1983 groundwater pH levels with pH levels present during the period between 1979 and 1983 (Figure 3) shows essentially the same pattern, that is, low (acidic) pH levels in the waters around the bituminous coal pile and neutral or alkaline pH levels in waters away from and around the lignite pile. In general the 1983 low pH levels in the groundwaters around the bituminous coal pile were slightly higher (less acidic) than they were during the previous years, especially from piezometers 19A and 19B which had very low pH levels in 1982.

(b) Alkalinity and Acidity

Summaries of the 1983 alkalinity and acidity levels in the groundwaters from the fuel storage areas are shown in Tables V and VI. Figures 4 and 5 show summaries of alkalinity and acidity levels in waters from six selected piezometers from 1979 through 1983.

Alkalinity and acidity parameters are opposites of each other. The waters having high alkalinities will have low or no acidities and the waters having high acidities will have low or no alkalinities.

From the acidity values shown in Table VI it is evident that waters from piezometer nests 12, 13, 14, 18 and 19 are very acidic and have low alkalinities, as shown in Table V. The acidity levels of the waters from these locations (all on the southeast corner of the bituminous coal pile) are also confirmed by the low pH (<4.3) levels shown on Table IV. Waters from the remaining piezometers had higher and variable alkalinity levels. Plots of alkalinity and acidity (to pH 8.3) levels, Figures 4 and 5, of groundwaters from six selected piezometers, illustrate the wide differences in these two characteristics of the groundwaters in the fuel storage area. Although the differences are broad, they have been consistent since 1979.

TABLE V

FUEL STORAGE AREA GROUNDWATER QUALITY
TBTGS - 1983

TEST: ALK HCO_3 mg/L $CaCO_3$

LOCATION	Sampling Date 830602	830603*	830726	830727*	830921	830922*
01A	340	370	340	380	350	400
03A	-	-	530	690	520	590
04A	350	400	410	640	430	600
05C	910	970	940	1100	920	900
06B	510	520	530	590	530	630
06C	840	900	860	950	520	950
07B	410	550	420	450	410	420
08B	83	110	78	100	95	80
12C	-	30	8	50	28	30
13B	-	50	<5	140	10	60
13C	-	40	<5	150	10	90
14A	-	110	<5	200	9	80
14B	-	50	8	100	19	70
14C	-	-	85	130	74	80
15A	740	870	730	1100	720	870
15B	1000	1100	990	1100	1000	1200
16A	750	840	730	920	740	830
16B	770	940	720	960	640	810
17A	540	860	530	930	650	830
17B	-	-	910	1100	820	1000
18A	-	110	<5	170	11	90
18B	-	90	25	170	49	130
19A	-	50	<5	160	8	60
19B	-	-	<5	40	<5	60

*TBTGS data on fresh samples taken the day before that shown. This is to avoid confusion in data input to computer (see page 7).

FUEL CELL GROUNDWATER-TBTGS-1983

Fig. 4 ALKALINITY (LAB) vs TIME

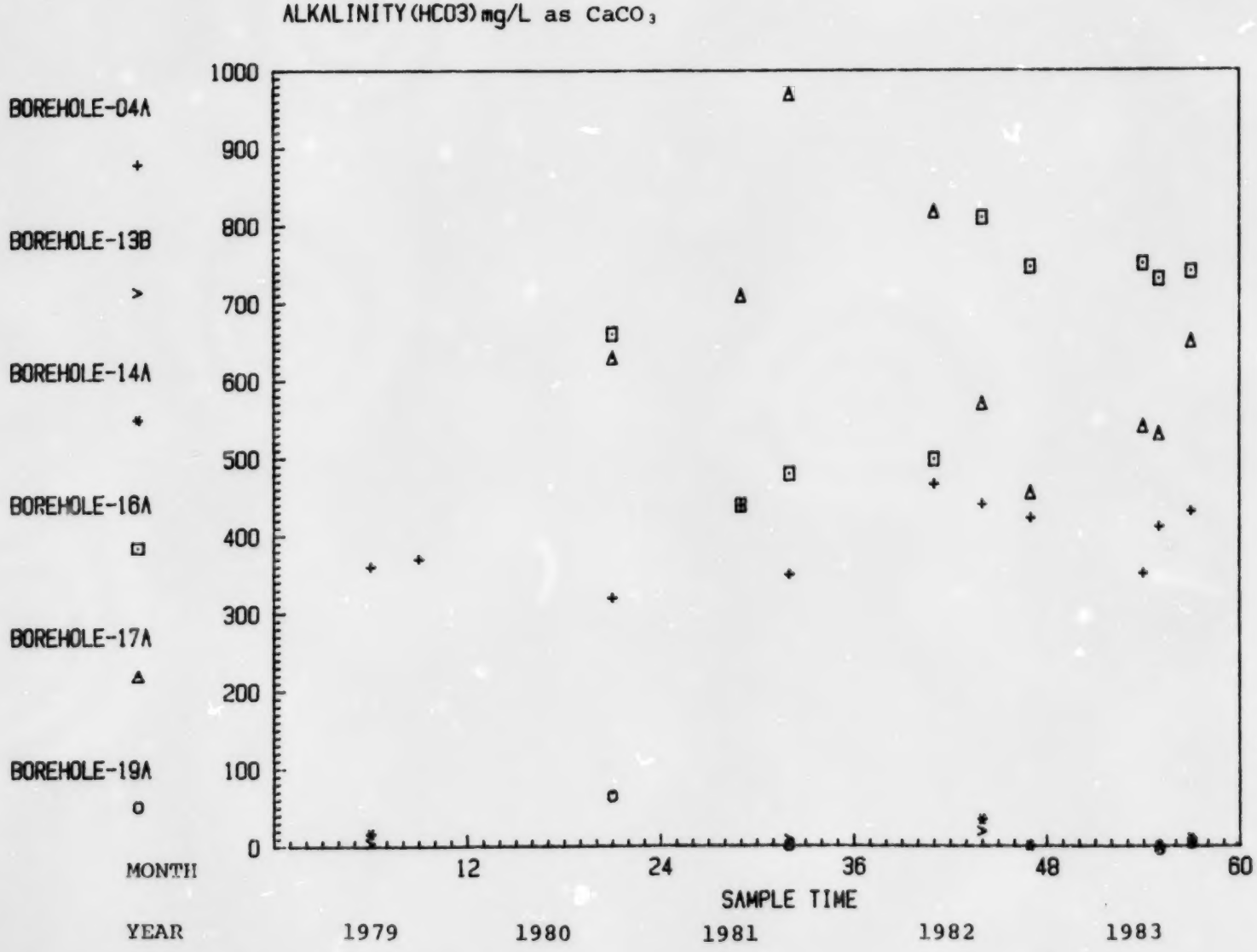


TABLE VI

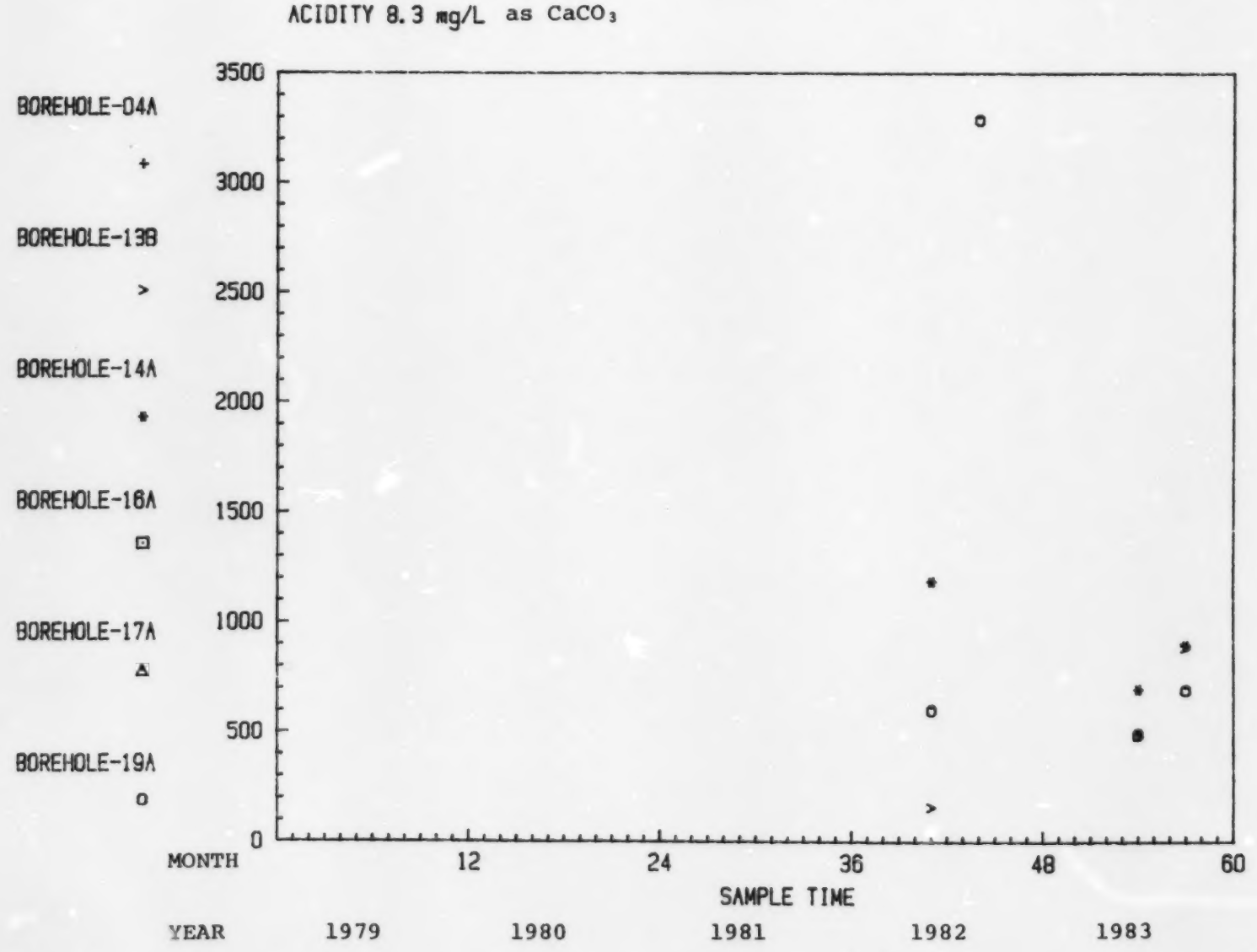
FUEL STORAGE AREA GROUNDWATER QUALITY
TBTGS - 1983

TEST: ACID 8.3 mg/L $CaCO_3$

LOCATION	Sampling Date 830602	830921
01A	-	-
03A	-	-
04A	-	-
05C	-	-
06B	-	-
06C	-	-
07B	-	-
08B	-	-
12C	94	130
13B	480	880
13C	560	820
14A	690	890
14B	280	290
15A	-	-
15B	-	-
16A	-	-
16B	-	-
17A	-	-
17B	-	-
18A	490	590
18B	160	150
19A	500	700
19B	-	650

FUEL CELL GROUNDWATER-TBTGS-1983

Fig. 5 ACIDITY 8.3 vs TIME



As was the case with the data acquired during the previous studies, the 1983 data also show that waters of lowest alkalinities, highest acidities and low pH values are present in wells around the bituminous coal pile and waters of highest alkalinities, no acidity and high pH levels were present in wells around the lignite coal pile. These findings are consistent with the known fact that normal bituminous coal drainage is acidic and the hypothesis that lignite coal drainage is neutral or alkaline.

(c) Conductivity

A summary of the 1983 conductivity levels is given in Table VII. Figure 6 shows a summary of conductivity levels in waters from six selected piezometers from 1979 through 1983.

As in 1982, groundwaters of low conductivities (<100 mS/m), indicating low ionic content of the waters, were present in piezometers 1A, 4A, 7B and 8B. Piezometer 1A is located well inland and west of the lignite pile and its water probably represents natural surface (rain) water. Piezometer 4A is close to the shore on the northwest corner of the lignite pile and piezometers 7B and 8B are also close to the shore but on the southeast corner of the lignite pile. These piezometers could have infiltrations of either lake or surface waters. It is more likely to be surface water infiltration as piezometer nests 5 and 6, that are also close to the shoreline and lake water, have much higher conductivities than the waters from piezometers 4A, 7B and 8B.

Waters from the remaining piezometers have higher and varying conductivities, the highest (>300 mS/m) of which are in waters from piezometers 13B, 13C, 14A, 18A, 19A and 19B. These piezometers are all located on the east and south sides of the bituminous coal pile and are the same piezometers that had waters of low pH and high acidity. The unusually high (2000 mS/m) conductivity value obtained in 1982 (August sample) for piezometers 19A and 19B did not occur this year.

Figure 6 shows that from 1979 through 1983 conductivity levels of the groundwaters remained at about constant levels except for piezometer 19A (and 19B) in 1982 when the conductivity was very high for the August sample. This high level would be suspect except that SO_4 and acidity levels were also high for this sample but not as high as that observed in 1982. The 1983 conductivity values of waters from piezometers 19A and 19B are higher than in most of the other waters. It appears, therefore, that something unusual occurred in the summer of 1982 to the water in piezometers 19A and 19B but was temporary.

TABLE VII

FUEL STORAGE AREA GROUNDWATER QUALITY
TBTGS - 1983

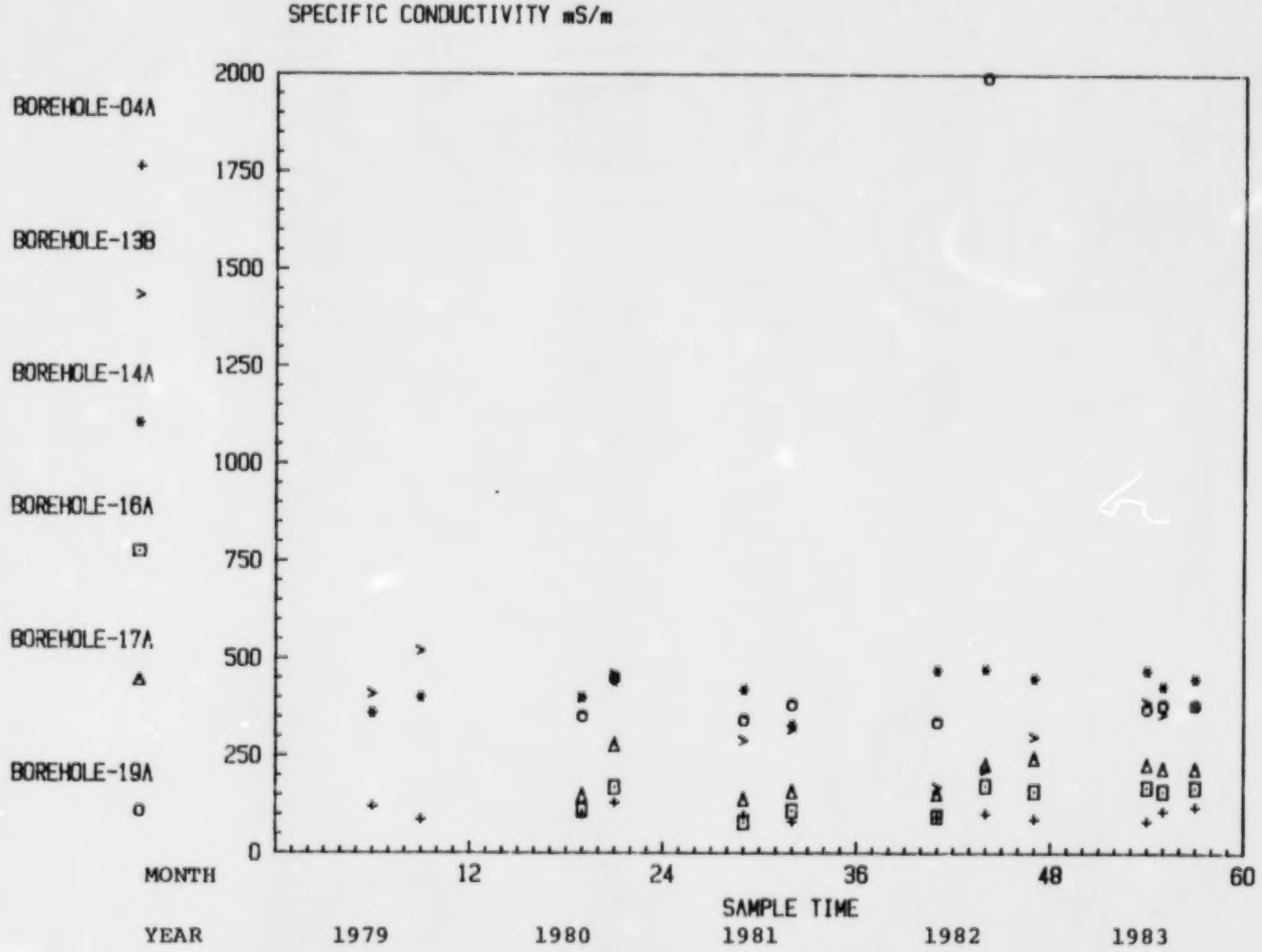
TEST: COND mS/m

LOCATION	Sampling Date 830602	830603*	830726	830727*	830921	830922*
01A	92	120	90	94	92	100
03A	-	-	110	130	110	120
04A	83	130	110	140	120	140
05C	190	250	200	250	200	230
06B	190	210	180	180	190	170
06C	210	270	200	250	200	230
07B	95	120	90	95	92	36
08B	50	68	34	38	25	23
12C	220	230	160	160	220	230
13B	390	410	360	380	380	400
13C	380	430	360	400	380	390
14A	470	540	430	440	450	400
14B	260	290	260	300	280	280
14C	-	170	140	160	150	160
15A	160	210	150	180	160	160
15B	190	210	170	250	170	180
16A	170	230	160	190	170	170
16B	140	190	140	170	130	140
17A	230	340	220	290	220	260
17B	-	220	190	250	170	230
18A	330	380	320	350	350	360
18B	210	260	200	240	210	230
19A	380	410	390	440	390	400
19B	-	470	430	490	430	420

*TBTGS data on fresh samples taken the day before that shown. This is to avoid confusion in data input to computer (see page 7).

FUEL CELL GROUNDWATER-TBTGS-1983

Fig. 6 SP. CONDUCTIVITY (LAB) vs TIME



(d) Iron

The iron concentrations obtained in 1983 are summarized in Table VIII. Figure 7 summarizes the Fe levels in waters from six selected piezometers from 1979 through 1980.

Low iron concentrations (<10 mg/L) were found, on at least one occasion during the year, in groundwaters from piezometers 1A, 6B, 7B 8B and 14C. These piezometers, with the exception of 14C, are located inland (1A), and east of the lignite coal pile (6B, 7B, 8B) and close to the shore where leachate contamination would not be expected. Piezometer 14C is south of the bituminous coal pile where the presence of leachate is expected. The low iron levels in piezometer 14C but not in 14A and 14B, could be due to the fact that it is shallower and therefore either filled with natural surface water or most of the iron has precipitated from the water.

High iron levels (>200 mg/L were found in piezometers 13B, 13C, 14A, 18A, 19A and 19B, all associated with waters having low pH, high conductivities and high SO_4 concentrations. These piezometers are all located around the southeast corner of the bituminous coal pile where a large effect from coal pile leachate is expected.

The moderately high (10 to 150 mg/L) iron concentrations found in piezometer nests 15 and 16 north of the lignite pile in 1982 were also found in 1983. Iron concentrations in the same range were also present again in piezometer nests 3, 4, 5 and 6 in the vicinity of the lignite coal pile.

Figure 7 shows that over the period from 1979 through 1983 iron concentrations in the groundwaters in the fuel storage areas varied widely over the entire site but were reasonably stable for specific locations.

(e) Sulphate

A summary of the 1983 sulphate concentrations in the groundwaters examined is shown in Table IX. Figure 8 shows a summary of SO_4 levels in waters from six selected piezometers from 1979 through 1983.

Low sulphate levels (<200 mg/L) were present in waters from piezometer nests surrounding the lignite pile. The 1983 SO_4 levels in piezometer 16B, inside the ditch, were considerably lower (1 to 10 mg/L) than the 1982 levels (123-158 mg/L). Sulphate levels in waters from piezometer nest 15, outside the ditch, were slightly higher, on average, than in waters from piezometer nest 16.

TABLE VIII

FUEL STORAGE AREA GROUNDWATER QUALITY
TBTGS - 1983

TEST: Fe mg/L

LOCATION	Sampling Date 830602	830726	830921
01A	0.1	1.2	6
03A	-	78	50
04A	73	130	92
05C	46	58	50
06B	0.3	23	16
06C	68	100	63
07B	0.2	3	5
08B	2.5	7	0.7
12C	42	30	32
13B	560	560	280
13C	520	520	310
14A	640	610	340
14B	150	190	120
14C	8	20	18
15A	98	130	68
15B	110	75	67
16A	79	100	52
16B	68	120	62
17A	120	200	120
17B	76	69	67
18A	100	410	260
18B	89	130	63
19A	430	530	290
19B	270	330	170

FUEL CELL GROUNDWATER-TBTGS-1983

Fig. 7 IRON vs TIME

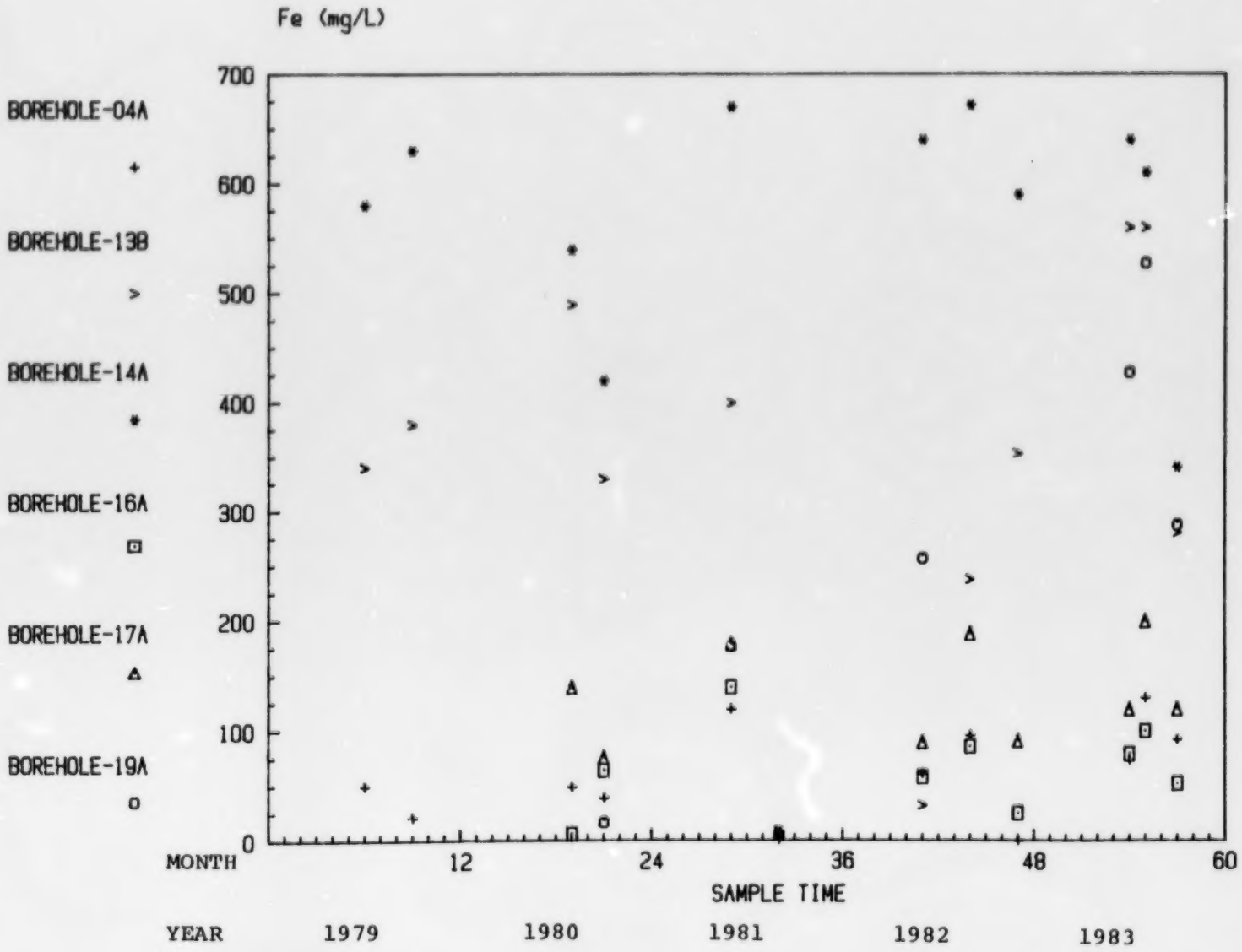


TABLE IX

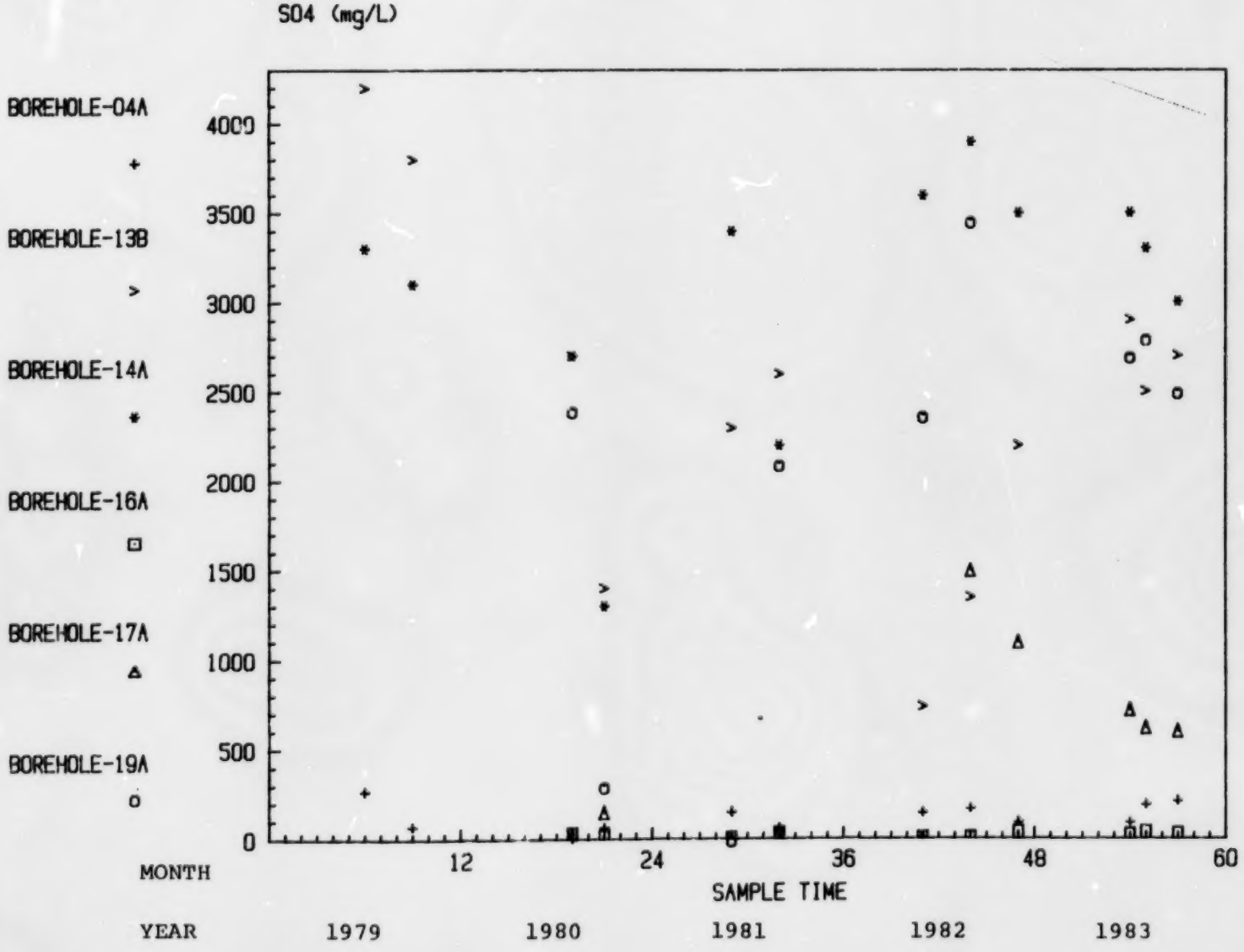
FUEL STORAGE AREA GROUNDWATER QUALITY
TBTGS - 1983

TEST: SO_4 mg/L

LOCATION	Sampling Date 830602	830726	830921
01A	2.2	3.9	1.1
03A	-	18	5.7
04A	89	190	210
05C	76	47	86
06B	3.1	1.3	<0.5
06C	180	180	880
07B	5.2	7.1	1.1
08B	99	55	9.3
12C	1400	740	1300
13B	2900	2500	2700
13C	2700	2700	2900
14A	3500	3300	3000
14B	1500	1600	1400
14C	-	650	560
15A	3.9	<0.5	1.1
15B	140	120	34
16A	17	33	23
16B	10	1.7	0.7
17A	720	620	600
17B	-	75	61
18A	2200	2300	2400
18B	1300	1200	920
19A	2700	2800	2500
19B	-	3200	2400

FUEL CELL GROUNDWATER-TBTGS-1983

Fig. 8 SULPHATE vs TIME



High sulphate levels (>500 mg/L) were present in piezometers around the bituminous coal pile and in piezometer 6C in the September sample which also had high Fe content and high conductivity. High SO_4 levels are expected around the bituminous coal pile but not in piezometer 6C which is distant from the bituminous coal pile, close to shore, and east of the lignite pile. These high SO_4 levels, accompanied with high Fe and acidity, and low pH and alkalinities, were present in waters from these locations since 1979, as shown in Figure 7. The high SO_4 levels in water from piezometer 6C occurred in the 1982 samples only although high Fe and conductivity levels were present since 1979.

As first observed in 1982 sulphate concentrations in waters from piezometers 4A, 5C, 6C and 15B, around the lignite coal pile, are again somewhat higher (50 to 900 mg/L) than they were prior to 1982. This suggests possible change in lignite leachate characteristics or of possible contamination of the waters in these locations by SO_4 rich aqueous wastes. The increased SO_4 levels are not, however, accompanied by changes in pH or alkalinity levels. The 1984 data might show if these changes in SO_4 levels are temporary or not.

(f) Trace Metals

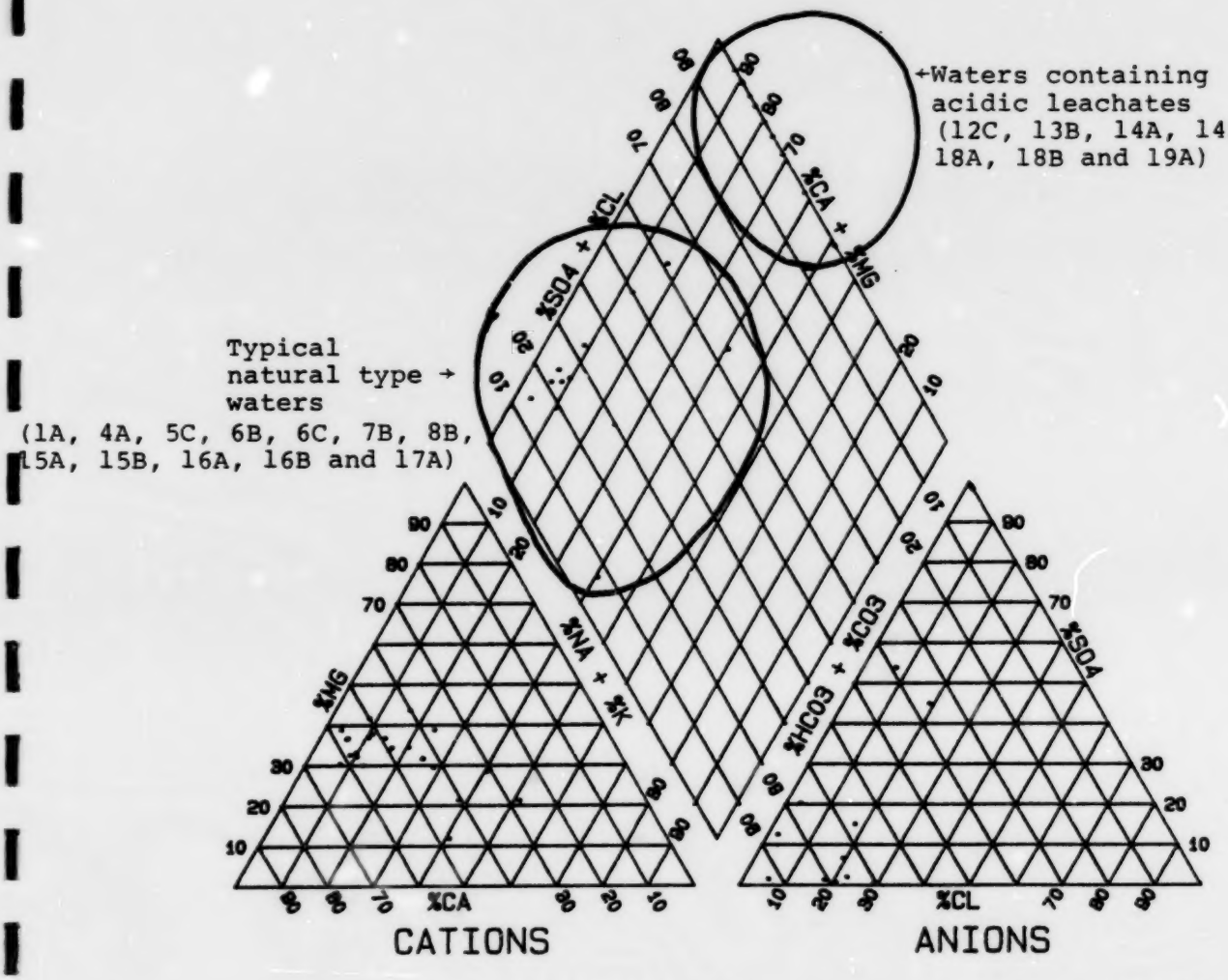
A cursory examination of the 1983 and of the previously obtained data on trace metals concentrations in the groundwaters around the fuel storage areas does not show any apparent significant changes or trends. However, it is planned to examine these data in detail, possibly in 1984, when all the data will be stored in the computer and be accessible for convenient comparison and statistical analysis.

(g) Piper Plots

As was the case with the previous years' data, the 1983 analytic data on the groundwater quality in the fuel storage areas show the presence of two distinct water types, as illustrated in a typical Piper plot, shown in Figure 9 selected from those given in Appendix B. One type represents groundwater in which alkaline earths and weak acid anions (HCO_3 and CO_3), resembling natural groundwater, predominate. This water type represents waters mainly from piezometers surrounding the lignite pile and those some distance west of the two piles. The other type represents groundwater in which alkaline earths and strong acid anions (SO_4 and Cl), predominate. This type represents waters, mainly from piezometers east and south of the bituminous coal pile, containing typical acidic bituminous coal leachates.

FIGURE 9

MAJOR ION CHEMISTRY
TBTGS FUEL
JUNE 02 1983
TYPE - WATER
FUEL STORAGE AREA GROUNDWATER QUALITY-TBTGS-1983


←Waters containing acidic leachates (12C, 13B, 14A, 14B, 18A, 18B and 19A)
Typical natural type → waters (1A, 4A, 5C, 6B, 6C, 7B, 8B, 15A, 15B, 16A, 16B and 17A)
%CA + %MG
%SO4 + %CL
%NA + %K
%HCO3 + %CO3
%MG
%CA
%SO4
%CL
CATIONS
ANIONS

84-103

(h) Drainage Ditches

In assessing the effect of the drainage ditches on the quality of the groundwater, the main characteristics of waters taken from piezometer nests 15 and 16 and 6 and 17 around the lignite coal pile, and piezometers 14 and 19 at the south side of the bituminous coal pile will be considered; pH, acidity, SO_4 and Fe concentrations will be used as the indicator parameters.

The data show that there is no major difference in pH levels in waters from piezometers 15A and 15B, both outside the drainage ditch, and piezometers 16A and 16B on the lignite pile side of the ditch. Sulphate concentrations are low (<5) in piezometer 15A (shallower) but are somewhat higher (average of 100) in piezometer 15B (deeper) than in 16A or 16B (average of 15). Iron concentrations in piezometer nest 15 were a little higher (average of 90) than in piezometer nest 16 (average of 80). It appears therefore that for this location the drainage ditch might have had some effect in diluting the concentration of SO_4 ions in the top layer of the soil on the lake side of the ditch but had no apparent effect on Fe concentrations.

Slightly higher pH levels and lower SO_4 and Fe concentrations exist in waters from piezometers 6B and 6C (outside the ditch) than from 17A and 17B (inside the ditch). This could be due to a dilution in the amount of SO_4 and Fe rich water on the lake side of the ditch.

Differences in pH and acidity levels in waters from piezometer nest 14 (inside the ditch) and piezometer nest 19 (outside the ditch) on the southeast corner of the bituminous coal pile are too small for any conclusions to be made on the effect of the ditch. However, there is evidence of some reduction in the SO_4 and Fe concentrations in the waters from piezometer 19A as compared to the concentrations in waters from piezometer 14A. This condition is reversed for piezometers 14B and 19B suggesting a heterogeneity in groundwater quality vertically and horizontally. It is perhaps too soon to assess the full effect of the ditches on groundwater quality.

CONCLUSIONS

Generally, the 1983 data on the groundwater charactertistics are similar to those acquired during the past years. The pattern of low pH levels and high sulphate and high iron concentrations around the bituminous coal pile observed in the past is also evident in the 1983 data. The high iron and sulphate concentrations that were found in 1982 in waters from piezometers around the lignite pile, on both sides of the ditch, were also observed in the 1983 data but they were at slightly lower levels.

Because pH and sulphate levels in waters on both sides of the drainage ditches are still inconsistent, no conclusion can be reached on the effect of the drainage ditches on groundwater quality. It is possible that a longer period of time is required for the soil conditions and water quality to stabilize. Further monitoring appears to be required before any effect of the drainage ditches on water quality will become evident.

A more detailed review of all data from 1979 through 1984 will be conducted for the 1984 summary report.

Approved:

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Manager
Chemical Research Dept

Submitted:

J. Complak

J. Complak
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Research Section

JC:rv:rdm

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APPENDIX A

POST-OPERATIONAL FUEL STORAGE
AREA GROUNDWATER QUALITY STUDIES
1983
THUNDER BAY TGS EXTENSION

GROUNDWATER CHARACTERISTICS

(All values are in mg/L except pH and conductivity
- pH in pH units
- Conductivity in mS/m)

FUEL STORAGE AREA GROUNDWATER QUALITY-TBTGS-1983

LOCATION : 01A

TEST	830602	830603*	830726	830727*	830921	830922*
			SAMPLING DATE			
ACIDB.3	--	--	--	--	--	--
AG	<.00020	--	--	--	--	--
AL	<.50	--	--	--	--	--
ALKCO3	<5.0	--	<5.0	--	<5.0	--
ALKHCO3	340.	--	340.	--	350.	--
ALKOH	<5.0	--	<5.0	--	<5.0	--
ALKTOT	--	370.	--	380.	--	400.
AS	.0010	--	--	--	--	--
B	.12	--	.15	--	.14	--
BA	<.10	--	--	--	--	--
BE	<.00020	--	--	--	--	--
CA	79.	--	81.	--	48.	--
CD	.00010	--	--	--	--	--
CL	100.	--	94.	--	93.	--
CO	.020	--	--	--	--	--
COND	92.	120.	90.	94.	92.	100.
CR	.013	--	--	--	--	--
CU	.0090	--	--	--	--	--
FE	.14	--	1.2	--	6.2	--
HG	<.00020	--	--	--	--	--
K	2.0	--	2.2	--	1.3	--
MG	35.	--	35.	--	19.	--
MN	7.4	--	8.3	--	3.8	--
MO	<.50	--	--	--	--	--
NA	52.	--	53.	--	29.	--
NI	.0080	--	--	--	--	--
NO3	--	--	--	--	--	--
PB	<.0020	--	--	--	--	--
PH	7.4	6.1	7.2	6.5	7.2	6.4
PO4	--	--	.020	--	.047	--
SE	<.0010	--	--	--	--	--
SI	22.	--	--	--	--	--
SO4	2.2	--	3.9	--	1.1	--
SR	<.050	--	--	--	--	--
TH	<.0050	--	--	--	--	--
TI	<1.0	--	--	--	--	--
V	<.50	--	--	--	--	--
ZN	<.020	--	--	--	--	--

*TBTGS data on fresh samples taken on the previous date to that shown.

FUEL STORAGE AREA GROUNDWATER QUALITY-TBTGS-1983

LOCATION : 03A

TEST	SAMPLING DATE 830602	830603 *	830726	830727 *	830921	830922 *
ACID6.3	--	--	--	--	--	--
AG	--	--	--	--	--	--
AL	--	--	--	--	--	--
ALKCO3	--	--	<5.0	--	<5.0	--
ALKHCO3	--	--	530.	--	520.	--
ALKOH	--	--	<5.0	--	<5.0	--
ALKTOT	--	--	--	690.	--	590.
AS	--	--	--	--	--	--
B	--	--	<.050	--	<.050	--
BA	--	--	--	--	--	--
BE	--	--	--	--	--	--
CA	--	--	120.	--	76.	--
CD	--	--	--	--	--	--
CL	--	--	59.	--	57.	--
CO	--	--	--	--	--	--
COND	--	--	110.	130.	110.	120.
CR	--	--	--	--	--	--
CU	--	--	--	--	--	--
FE	--	--	78.	--	50.	--
HG	--	--	--	--	--	--
K	--	--	2.2	--	1.6	--
MG	--	--	55.	--	33.	--
MN	--	--	1.5	--	.80	--
MO	--	--	--	--	--	--
NA	--	--	42.	--	28.	--
NI	--	--	--	--	--	--
NO3	--	--	--	--	--	--
PB	--	--	--	--	--	--
PH	--	--	6.8	6.0	6.9	6.5
PO4	--	--	.020	--	.060	--
SE	--	--	--	--	--	--
SI	--	--	--	--	--	--
SO4	--	--	18.	--	5.7	--
SR	--	--	--	--	--	--
TH	--	--	--	--	--	--
TI	--	--	--	--	--	--
V	--	--	--	--	--	--
ZN	--	--	--	--	--	--

*TBTGS data on fresh samples taken on the previous date to that shown.

FUEL STORAGE AREA GROUNDWATER QUALITY-TBTGS-1983

LOCATION : 04A

TEST	SAMPLING DATE 830602	830603*	830726	830727*	830921	830922*
ACIDB.3	--	--	--	--	--	--
AG	<.00020	--	--	--	--	--
AL	<.50	--	--	--	--	--
ALKCO3	<5.0	--	<5.0	--	<5.0	--
ALKHCO3	350.	--	410.	--	430.	--
ALKOH	<5.0	--	<5.0	--	<5.0	--
ALKTOT	--	400.	--	640.	--	600.
AS	.0040	--	--	--	--	--
B	.090	--	.080	--	.20	--
BA	.19	--	--	--	--	--
BE	<.00020	--	--	--	--	--
CA	87.	--	130.	--	79.	--
CD	.00010	--	--	--	--	--
CL	11.	--	22.	--	25.	--
CO	.0020	--	--	--	--	--
COND	83.	130.	110.	140.	120.	140.
CR	.010	--	--	--	--	--
CU	.20	--	--	--	--	--
FE	73.	--	130.	--	92.	--
HG	.0030	--	--	--	--	--
K	5.5	--	6.0	--	3.4	--
MG	44.	--	61.	--	32.	--
MN	.99	--	1.7	--	.90	--
MO	<.50	--	--	--	--	--
NA	14.	--	15.	--	7.4	--
NI	<.0050	--	--	--	--	--
NO3	--	--	--	--	--	--
PB	<.0020	--	--	--	--	--
PH	6.8	6.6	6.6	6.7	6.5	6.5
PO4	--	--	.030	--	.063	--
SE	<.0010	--	--	--	--	--
SI	14.	--	--	--	--	--
SO4	89.	--	190.	--	210.	--
SR	.29	--	--	--	--	--
TH	<.0050	--	--	--	--	--
TI	<1.0	--	--	--	--	--
V	<.50	--	--	--	--	--
ZN	<.020	--	--	--	--	--

*TBTGS data on fresh samples taken on the previous date to that shown.

FUEL STORAGE AREA GROUNDWATER QUALITY-TBTGS-1983

LOCATION : OSC

TEST	830602	830603*	830726	830727*	830921	830922*
	SAMPLING DATE					
ACIDB.3	--	--	--	--	--	--
AG	<.00020	--	--	--	--	--
AL	<.50	--	--	--	--	--
ALKCO3	<5.0	--	<5.0	--	<5.0	--
ALKHCO3	910.	--	940.	--	920.	--
ALKOH	<5.0	--	<5.0	--	<5.0	--
ALKTOT	--	970.	--	1100.	--	900.
AS	.0050	--	--	--	--	--
B	.090	--	.080	--	<.050	--
BA	.27	--	--	--	--	--
BE	<.00020	--	--	--	--	--
CA	270.	--	280.	--	160.	--
CD	<.00010	--	--	--	--	--
CL	170.	--	160.	--	140.	--
CO	.0020	--	--	--	--	--
COND	190.	250.	200.	250.	200.	230.
CR	.0070	--	--	--	--	--
CU	.10	--	--	--	--	--
FE	46.	--	58.	--	50.	--
HG	<.00020	--	--	--	--	--
K	3.9	--	3.7	--	2.1	--
MG	95.	--	95.	--	50.	--
MN	2.6	--	3.1	--	1.5	--
MO	<.50	--	--	--	--	--
NA	52.	--	50.	--	28.	--
NI	.026	--	--	--	--	--
NO3	--	--	--	--	--	--
PB	<.0020	--	--	--	--	--
PH	7.6	6.8	7.0	6.7	7.1	6.1
PO4	--	--	.060	--	.016	--
SE	<.0010	--	--	--	--	--
SI	14.	--	--	--	--	--
SO4	76.	--	47.	--	86.	--
SR	.29	--	--	--	--	--
TH	<.0050	--	--	--	--	--
TI	<1.0	--	--	--	--	--
V	<.50	--	--	--	--	--
ZN	.020	--	--	--	--	--

*TBTGS data on fresh samples taken on the previous date to that shown.

FUEL STORAGE AREA GROUNDWATER QUALITY-TBTGS-1983

LOCATION : 06B

TEST	830602	830603 *	830726	830727 *	830921	830922 *
			SAMPLING DATE			
ACIDB.3	--	--	--	--	--	--
AG	<.00020	--	--	--	--	--
AL	<.50	--	--	--	--	--
ALKCO3	<5.0	--	<5.0	--	<5.0	--
ALKHCO3	510.	--	530.	--	530.	--
ALKOH	<5.0	--	<5.0	--	<5.0	--
ALKTOT	--	520.	--	590.	--	630.
AS	.0030	--	--	--	--	--
B	<.050	--	.090	--	.080	--
BA	.34	--	--	--	--	--
BE	<.00020	--	--	--	--	--
CA	210.	--	200.	--	120.	--
CD	<.00010	--	--	--	--	--
CL	360.	--	350.	--	310.	--
CO	.0040	--	--	--	--	--
COND	190.	210.	180.	180.	190.	170.
CR	.011	--	--	--	--	--
CU	.0060	--	--	--	--	--
FE	.25	--	23.	--	16.	--
HG	<.00020	--	--	--	--	--
K	3.4	--	3.6	--	2.1	--
MG	68.	--	64.	--	40.	--
MN	2.1	--	2.6	--	1.3	--
MO	<.50	--	--	--	--	--
NA	54.	--	50.	--	29.	--
NI	<.0050	--	--	--	--	--
NO3	--	--	--	--	--	--
PB	<.0020	--	--	--	--	--
PH	7.5	6.8	7.0	6.9	7.3	5.9
PO4	--	--	.030	--	.045	--
SE	<.0010	--	--	--	--	--
SI	23.	--	--	--	--	--
SO4	3.1	--	1.3	--	<.50	--
SR	.19	--	--	--	--	--
TH	<.0050	--	--	--	--	--
TI	<1.0	--	--	--	--	--
V	<.50	--	--	--	--	--
ZN	<.020	--	--	--	--	--

*TBTGS data on fresh samples taken on the previous date to that shown.

FUEL STORAGE AREA GROUNDWATER QUALITY-TBTGS-1983

LOCATION : 06C

TEST	830602	830603*	830726	830727*	830921	830922*
			SAMPLING DATE			
ACIDB.3	--	--	--	--	--	--
AG	<.00020	--	--	--	--	--
AL	<.50	--	--	--	--	--
ALKCO3	<5.0	--	<5.0	--	<5.0	--
ALKHCO3	840.	--	860.	--	520.	--
ALKOH	<5.0	--	<5.0	--	<5.0	--
ALKTOT	--	900.	--	950.	--	950.
AS	.0050	--	--	--	--	--
B	.060	--	.19	--	.11	--
BA	.35	--	--	--	--	--
BE	<.00020	--	--	--	--	--
CA	300.	--	280.	--	160.	--
CD	<.00010	--	--	--	--	--
CL	160.	--	160.	--	100.	--
CO	.0030	--	--	--	--	--
COND	210.	270.	200.	250.	200.	230.
CR	.0090	--	--	--	--	--
CU	.053	--	--	--	--	--
FE	68.	--	100.	--	63.	--
HG	<.00020	--	--	--	--	--
K	2.6	--	2.8	--	1.9	--
MG	100.	--	99.	--	56.	--
MN	2.5	--	3.0	--	1.4	--
MO	<.50	--	--	--	--	--
NA	51.	--	50.	--	29.	--
NI	<.0050	--	--	--	--	--
NO3	--	--	--	--	--	--
PB	<.0020	--	--	--	--	--
PH	7.3	6.9	6.8	6.8	7.0	6.3
PO4	--	--	.060	--	.018	--
SE	<.0010	--	--	--	--	--
SI	15.	--	--	--	--	--
SO4	180.	--	180.	--	880.	--
SR	.30	--	--	--	--	--
TH	<.0050	--	--	--	--	--
TI	<1.0	--	--	--	--	--
V	<.50	--	--	--	--	--
ZN	.020	--	--	--	--	--

*TBTGS data on fresh samples taken on the previous date to that shown.

FUEL STORAGE AREA GROUNDWATER QUALITY-TBTGS-1983

LOCATION : 07B

TEST	830602	830603*	830726	830727*	830921	830922*
			SAMPLING DATE			
ACID8.3	--	--	--	--	--	--
AG	<.00020	--	--	--	--	--
AL	<.50	--	--	--	--	--
ALKCO3	<5.0	--	<5.0	--	<5.0	--
ALKHCO3	410.	--	420.	--	410.	--
ALKOH	<5.0	--	<5.0	--	<5.0	--
ALKTOT	--	550.	--	450.	--	420.
AS	.0030	--	--	--	--	--
B	.15	--	.20	--	.18	--
BA	.10	--	--	--	--	--
BE	<.00020	--	--	--	--	--
CA	120.	--	110.	--	73.	--
CD	.00010	--	--	--	--	--
CL	65.	--	58.	--	52.	--
CO	<.0020	--	--	--	--	--
COND	95.	120.	90.	95.	92.	36.
CR	.014	--	--	--	--	--
CU	.026	--	--	--	--	--
FE	.15	--	7.7	--	5.1	--
HG	<.00020	--	--	--	--	--
K	1.9	--	1.7	--	1.2	--
MG	40.	--	38.	--	23.	--
MN	1.5	--	1.9	--	.98	--
MO	<.50	--	--	--	--	--
NA	24.	--	20.	--	12.	--
NI	.0050	--	--	--	--	--
NO3	--	--	--	--	--	--
PB	<.0020	--	--	--	--	--
PH	7.6	6.6	7.2	6.4	7.4	6.5
PO4	--	--	.080	--	.040	--
SE	<.0010	--	--	--	--	--
SI	26.	--	--	--	--	--
SO4	5.2	--	7.1	--	1.1	--
SR	.16	--	--	--	--	--
TH	<.0050	--	--	--	--	--
TI	<1.0	--	--	--	--	--
V	<.50	--	--	--	--	--
ZN	<.020	--	--	--	--	--

*TBTGS data on fresh samples taken on the previous date to that shown.

FUEL STORAGE AREA GROUNDWATER QUALITY-TBTGS-1983

LOCATION : 08B

TEST	830602	830603*	830726	830727*	830921	830922*
			SAMPLING DATE			
ACIDB.3	--	--	--	--	--	--
AG	<.00020	--	--	--	--	--
AL	<.50	--	--	--	--	--
ALKCO3	<5.0	--	<5.0	--	<5.0	--
ALKHCO3	83.	--	78.	--	95.	--
ALKOH	<5.0	--	<5.0	--	<5.0	--
ALKTOT	--	110.	--	100.	--	80.
AS	.0050	--	--	--	--	--
B	1.1	--	1.2	--	1.2	--
BA	.19	--	--	--	--	--
BE	<.00020	--	--	--	--	--
CA	44.	--	31.	--	13.	--
CD	.00010	--	--	--	--	--
CL	31.	--	17.	--	9.2	--
CO	.0030	--	--	--	--	--
COND	50.	68.	34.	38.	25.	23.
CR	.013	--	--	--	--	--
CU	.022	--	--	--	--	--
FE	2.5	--	7.4	--	.70	--
HG	<.00020	--	--	--	--	--
K	3.1	--	2.4	--	1.7	--
MG	6.6	--	4.7	--	1.7	--
MN	.84	--	.62	--	.25	--
MO	<.50	--	--	--	--	--
NA	42.	--	30.	--	15.	--
NI	.0080	--	--	--	--	--
NO3	--	--	--	--	--	--
PB	<.0020	--	--	--	--	--
PH	7.6	6.5	7.0	6.6	7.7	6.9
PO4	--	--	.080	--	.082	--
SE	<.0010	--	--	--	--	--
SI	15.	--	--	--	--	--
SO4	99.	--	55.	--	9.3	--
SR	.36	--	--	--	--	--
TH	<.0050	--	--	--	--	--
TI	<1.0	--	--	--	--	--
V	<.50	--	--	--	--	--
ZN	<.020	--	--	--	--	--

*TBTGS data on fresh samples taken on the previous date to that shown.

FUEL STORAGE AREA GROUNDWATER QUALITY-TBTGS-1983

LOCATION : 12C

TEST	SAMPLING DATE 830602	830603*	830726	830727*	830921	830922*
ACID8.3	94.	--	--	--	130.	--
AG	<.00020	--	--	--	--	--
AL	<.50	--	--	--	--	--
ALKCO3	--	--	<5.0	--	<5.0	--
ALKHCO3	--	--	8.5	--	28.	--
ALKOH	--	--	<5.0	--	<5.0	--
ALKTOT	--	30.	--	50.	--	30.
AS	<.0010	--	--	--	--	--
B	1.2	--	1.3	--	1.7	--
BA	<.10	--	--	--	--	--
BE	.0013	--	--	--	--	--
CA	320.	--	200.	--	180.	--
CD	.0034	--	--	--	--	--
CL	17.	--	25.	--	24.	--
CO	.33	--	--	--	--	--
COND	220.	230.	160.	160.	220.	230.
CR	.0090	--	--	--	--	--
CU	.040	--	--	--	--	--
FE	42.	--	30.	--	32.	--
HG	<.00020	--	--	--	--	--
K	6.9	--	6.7	--	4.9	--
MG	96.	--	60.	--	53.	--
MN	61.	--	39.	--	3.0	--
MO	<.50	--	--	--	--	--
NA	43.	--	42.	--	31.	--
NI	.23	--	--	--	--	--
NO3	<5.0	--	--	--	--	--
PB	<.0020	--	--	--	--	--
PH	4.3	6.2	5.4	6.5	5.8	5.8
PO4	--	--	.11	--	<.0050	--
SE	<.0010	--	--	--	--	--
SI	22.	--	--	--	--	--
SO4	1400.	--	740.	--	1300.	--
SR	1.1	--	--	--	--	--
TH	<.0050	--	--	--	--	--
TI	<1.0	--	--	--	--	--
V	<.50	--	--	--	--	--
ZN	.51	--	--	--	--	--

*TBTGS data on fresh samples taken on the previous date to that shown.

FUEL STORAGE AREA GROUNDWATER QUALITY-TBTGS-1983

LOCATION : 13B

TEST	830602	830603*	830726	830727*	830921	830922*
	SAMPLING DATE					
ACID8.3	480.	--	--	--	880.	--
AG	<.00020	--	--	--	--	--
AL	<.50	--	--	--	--	--
ALKCO3	--	--	<5.0	--	<5.0	--
ALKHCO3	--	--	<5.0	--	10.	--
ALKOH	--	--	<5.0	--	<5.0	--
ALKTOT	--	50.	--	140.	--	60.
AS	<.0010	--	--	--	--	--
B	2.0	--	2.9	--	3.7	--
BA	<.10	--	--	--	--	--
BE	<.00020	--	--	--	--	--
CA	410.	--	440.	--	230.	--
CD	<.00010	--	--	--	--	--
CL	22.	--	25.	--	29.	--
CO	.24	--	--	--	--	--
COND	390.	410.	360.	380.	380.	400.
CR	.015	--	--	--	--	--
CU	.034	--	--	--	--	--
FE	560.	--	560.	--	280.	--
HG	.00070	--	--	--	--	--
K	7.7	--	8.0	--	4.5	--
MG	170.	--	170.	--	95.	--
MN	79.	--	78.	--	3.9	--
MO	<.50	--	--	--	--	--
NA	92.	--	80.	--	45.	--
NI	.15	--	--	--	--	--
NO3	24.	--	--	--	--	--
PB	<.0020	--	--	--	--	--
PH	3.7	6.3	5.1	6.0	5.0	6.2
PO4	--	--	<.0050	--	<.0050	--
SE	<.0010	--	--	--	--	--
SI	29.	--	--	--	--	--
SO4	2900.	--	2500.	--	2700.	--
SR	.80	--	--	--	--	--
TH	<.0050	--	--	--	--	--
TI	<1.0	--	--	--	--	--
V	<.50	--	--	--	--	--
ZN	.10	--	--	--	--	--

*TBTGS data on fresh samples taken on the previous date to that shown.

FUEL STORAGE AREA GROUNDWATER QUALITY-TBTGS-1983

LOCATION : 13C

TEST	SAMPLING DATE 830602	830603*	830726	830727*	830921	830922*
ACIDB.3	560.	--	--	--	820.	--
AG	<.00020	--	--	--	--	--
AL	<.50	--	--	--	--	--
ALKCO3	--	--	<5.0	--	<5.0	--
ALKHCO3	--	--	<5.0	--	10.	--
ALKOH	--	--	<5.0	--	<5.0	--
ALKTOT	--	40.	--	150.	--	90.
AS	<.0010	--	--	--	--	--
B	1.9	--	2.8	--	3.6	--
BA	<.10	--	--	--	--	--
BE	<.00020	--	--	--	--	--
CA	400.	--	460.	--	230.	--
CD	<.00010	--	--	--	--	--
CL	26.	--	25.	--	28.	--
CO	.18	--	--	--	--	--
COND	380.	430.	360.	400.	380.	390.
CR	.012	--	--	--	--	--
CU	.018	--	--	--	--	--
FE	520.	--	520.	--	310.	--
HG	.00070	--	--	--	--	--
K	8.2	--	8.1	--	4.7	--
MG	180.	--	180.	--	96.	--
MN	75.	--	80.	--	4.1	--
MO	<.50	--	--	--	--	--
NA	95.	--	91.	--	44.	--
NI	.0060	--	--	--	--	--
NO3	20.	--	--	--	--	--
PB	<.0020	--	--	--	--	--
PH	3.8	6.4	5.2	6.1	5.0	6.2
PO4	--	--	<.0050	--	<.0050	--
SE	<.0010	--	--	--	--	--
SI	28.	--	--	--	--	--
SO4	2700.	--	2700.	--	2900.	--
SR	.76	--	--	--	--	--
TH	<.0050	--	--	--	--	--
TI	<1.0	--	--	--	--	--
V	<.50	--	--	--	--	--
ZN	.060	--	--	--	--	--

*TBTGS data on fresh samples taken on the previous date to that shown.

FUEL STORAGE AREA GROUNDWATER QUALITY-TBTGS-1983

LOCATION : 14A

TEST	830602	830603*	830726	830727*	830921	830922*
			SAMPLING DATE			
ACIDB.3	690.	--	--	--	890.	--
AG	<.00020	--	--	--	--	--
AL	<.50	--	--	--	--	--
ALKCO3	--	--	<5.0	--	<5.0	--
ALKHCO3	--	--	<5.0	--	9.0	--
ALKOH	--	--	<5.0	--	<5.0	--
ALKTOT	--	110.	--	200.	--	80.
AS	<.0010	--	--	--	--	--
B	.52	--	1.5	--	2.0	--
BA	<.10	--	--	--	--	--
BE	<.00020	--	--	--	--	--
CA	420.	--	450.	--	200.	--
CD	.00010	--	--	--	--	--
CL	54.	--	55.	--	51.	--
CO	.060	--	--	--	--	--
COND	470.	540.	430.	440.	450.	400.
CR	.019	--	--	--	--	--
CU	.029	--	--	--	--	--
FE	640.	--	610.	--	340.	--
HG	<.00020	--	--	--	--	--
K	4.2	--	4.3	--	2.4	--
MG	280.	--	230.	--	130.	--
MN	90.	--	86.	--	3.7	--
MO	<.50	--	--	--	--	--
NA	200.	--	190.	--	100.	--
NI	.027	--	--	--	--	--
NO3	21.	--	--	--	--	--
PB	<.0020	--	--	--	--	--
PH	3.8	6.0	5.1	6.4	5.0	5.9
PO4	--	--	<.0050	--	<.0050	--
SE	<.0010	--	--	--	--	--
SI	32.	--	--	--	--	--
SO4	3500.	--	3300.	--	3000.	--
SR	.40	--	--	--	--	--
TH	<.0050	--	--	--	--	--
TI	<1.0	--	--	--	--	--
V	<.50	--	--	--	--	--
ZN	.030	--	--	--	--	--

*TBTGS data on fresh samples taken on the previous date to that shown.

FUEL STORAGE AREA GROUNDWATER QUALITY-TBTGS-1983

LOCATION : 14B

TEST	SAMPLING DATE 830602	830603*	830726	830727*	830921	830922*
ACID8.3	280.	--	--	--	290.	--
AG	<.00020	--	--	--	--	--
AL	<.50	--	--	--	--	--
ALKCO3	--	--	<5.0	--	<5.0	--
ALKHCO3	--	--	8.0	--	19.	--
ALKOH	--	--	<5.0	--	<5.0	--
ALKTOT	--	50.	--	100.	--	70.
AS	<.0010	--	--	--	--	--
B	1.1	--	1.5	--	1.8	--
BA	<.10	--	--	--	--	--
BE	<.00020	--	--	--	--	--
CA	220.	--	220.	--	150.	--
CD	.00010	--	--	--	--	--
CL	12.	--	14.	--	22.	--
CO	.11	--	--	--	--	--
COND	260.	290.	260.	300.	280.	280.
CR	.015	--	--	--	--	--
CU	.045	--	--	--	--	--
FE	150.	--	190.	--	120.	--
HG	.00050	--	--	--	--	--
K	4.7	--	5.5	--	3.8	--
MG	93.	--	99.	--	64.	--
MN	39.	--	44.	--	2.4	--
MO	<.50	--	--	--	--	--
NA	170.	--	180.	--	120.	--
NI	.074	--	--	--	--	--
NO3	13.	--	--	--	--	--
PB	<.0020	--	--	--	--	--
PH	3.8	6.2	5.7	6.2	5.6	6.2
PO4	--	--	<.0050	--	<.0050	--
SE	<.0010	--	--	--	--	--
SI	24.	--	--	--	--	--
SO4	1500.	--	1600.	--	1400.	--
SR	.40	--	--	--	--	--
TH	<.0050	--	--	--	--	--
TI	<1.0	--	--	--	--	--
V	<.50	--	--	--	--	--
ZN	<.020	--	--	--	--	--

*TBTGS data on fresh samples taken on the previous date to that shown.

FUEL STORAGE AREA GROUNDWATER QUALITY-TBTGS-1983

LOCATION : 14C

TEST	830602	830603*	830726	830727*	830921	830922*
	SAMPLING DATE					
ACIDB.3	--	--	--	--	--	--
AG	<.00020	--	--	--	--	--
AL	<.50	--	--	--	--	--
ALKCO3	--	--	<5.0	--	<5.0	--
ALKHCO3	--	--	85.	--	74.	--
ALKOH	--	--	<5.0	--	<5.0	--
ALKTOT	--	--	--	130.	--	80.
AS	<.0010	--	--	--	--	--
B	--	--	1.5	--	.99	--
BA	<.10	--	--	--	--	--
BE	<.00020	--	--	--	--	--
CA	120.	--	110.	--	73.	--
CD	.00010	--	--	--	--	--
CL	--	--	7.1	--	11.	--
CO	.0040	--	--	--	--	--
COND	--	170.	140.	160.	150.	160.
CR	.014	--	--	--	--	--
CU	.011	--	--	--	--	--
FE	7.7	--	20.	--	18.	--
HG	.00050	--	--	--	--	--
K	2.3	--	3.5	--	1.6	--
MG	39.	--	34.	--	23.	--
MN	13.	--	12.	--	.70	--
MO	<.50	--	--	--	--	--
NA	130.	--	150.	--	84.	--
NI	.0060	--	--	--	--	--
NO3	--	--	--	--	--	--
PB	<.0020	--	--	--	--	--
PH	--	6.4	6.6	6.4	6.4	6.5
PO4	--	--	<.0050	--	<.0050	--
SE	<.0010	--	--	--	--	--
SI	--	--	--	--	--	--
SO4	--	--	650.	--	560.	--
SR	<.50	--	--	--	--	--
TH	<.0050	--	--	--	--	--
TI	<1.0	--	--	--	--	--
V	<.50	--	--	--	--	--
ZN	<.020	--	--	--	--	--

*TBTGS data on fresh samples taken on the previous date to that shown.

FUEL STORAGE AREA GROUNDWATER QUALITY-TBTGS-1983

LOCATION : 15A

TEST	830602	830603*	830726	830727*	830921	830922*
	SAMPLING DATE					
ACID8.3	--	--	--	--	--	--
AG	<.00020	--	--	--	--	--
AL	<.50	--	--	--	--	--
ALKCO3	<5.0	--	<5.0	--	<5.0	--
ALKHCO3	740.	--	730.	--	720.	--
ALKOH	<5.0	--	<5.0	--	<5.0	--
ALKTOT	--	870.	--	1100.	--	870.
AS	.0050	--	--	--	--	--
B	.92	--	<.050	--	.32	--
BA	.20	--	--	--	--	--
BE	<.00020	--	--	--	--	--
CA	220.	--	200.	--	110.	--
CD	<.00010	--	--	--	--	--
CL	140.	--	140.	--	120.	--
CO	.0060	--	--	--	--	--
COND	160.	210.	150.	180.	160.	160.
CR	.015	--	--	--	--	--
CU	.018	--	--	--	--	--
FE	98.	--	130.	--	68.	--
HG	<.00020	--	--	--	--	--
K	2.0	--	2.0	--	1.1	--
MG	85.	--	82.	--	45.	--
MN	3.7	--	3.9	--	1.9	--
MO	<.50	--	--	--	--	--
NA	27.	--	26.	--	14.	--
NI	.0060	--	--	--	--	--
NO3	--	--	--	--	--	--
PB	<.0020	--	--	--	--	--
PH	7.2	6.4	6.8	6.8	6.7	6.5
PO4	--	--	.090	--	.030	--
SE	<.0010	--	--	--	--	--
SI	14.	--	--	--	--	--
SO4	3.9	--	<.50	--	1.1	--
SR	.23	--	--	--	--	--
TH	<.0050	--	--	--	--	--
TI	<1.0	--	--	--	--	--
V	<.50	--	--	--	--	--
ZN	.040	--	--	--	--	--

*TBTGS data on fresh samples taken on the previous date to that shown.

FUEL STORAGE AREA GROUNDWATER QUALITY-TBTGS-1983

LOCATION : 15B

TEST	830602	830603*	830726	830727*	830921	830922*
	SAMPLING DATE					
ACIDB.3	--	--	--	--	--	--
AG	<.00020	--	--	--	--	--
AL	<.50	--	--	--	--	--
ALKCO3	<5.0	--	<5.0	--	<5.0	--
ALKHCO3	1000.	--	990.	--	1000.	--
ALKOH	<5.0	--	<5.0	--	<5.0	--
ALKTOT	--	1100.	--	1100.	--	1200.
AS	.0020	--	--	--	--	--
B	.080	--	.18	--	.34	--
BA	<.10	--	--	--	--	--
BE	<.00020	--	--	--	--	--
CA	270.	--	240.	--	150.	--
CD	<.00010	--	--	--	--	--
CL	20.	--	24.	--	28.	--
CO	.012	--	--	--	--	--
COND	190.	210.	170.	250.	170.	180.
CR	.011	--	--	--	--	--
CU	.0070	--	--	--	--	--
FE	110.	--	75.	--	67.	--
HG	.00090	--	--	--	--	--
K	8.0	--	9.3	--	8.4	--
MG	110.	--	100.	--	62.	--
MN	13.	--	14.	--	5.5	--
MO	<.50	--	--	--	--	--
NA	17.	--	20.	--	15.	--
NI	.010	--	--	--	--	--
NO3	--	--	--	--	--	--
PB	<.0020	--	--	--	--	--
PH	7.2	6.4	7.1	6.8	6.8	6.5
PO4	--	--	.020	--	.067	--
SE	<.0010	--	--	--	--	--
SI	11.	--	--	--	--	--
SO4	140.	--	120.	--	34.	--
SR	.26	--	--	--	--	--
TH	<.0050	--	--	--	--	--
TI	<1.0	--	--	--	--	--
V	<.50	--	--	--	--	--
ZN	<.020	--	--	--	--	--

*TLTGS data on fresh samples taken on the previous date to that shown.

FUEL STORAGE AREA GROUNDWATER QUALITY-TBTGS-1983

LOCATION : 16A

TEST	830602	830603*	830726	830727*	830921	830922*
			SAMPLING DATE			
ACID8.3	--	--	--	--	--	--
AG	<.00020	--	--	--	--	--
AL	<.50	--	--	--	--	--
ALKCO3	<5.0	--	<5.0	--	<5.0	--
ALKHCO3	750.	--	730.	--	740.	--
ALKOH	<5.0	--	<5.0	--	<5.0	--
ALKTOT	--	840.	--	920.	--	830.
AS	.0040	--	--	--	--	--
B	.080	--	.16	--	.19	--
BA	.19	--	--	--	--	--
BE	<.00020	--	--	--	--	--
CA	230.	--	210.	--	140.	--
CD	<.00010	--	--	--	--	--
CL	160.	--	160.	--	140.	--
CO	.0030	--	--	--	--	--
COND	170.	230.	160.	190.	170.	170.
CR	.011	--	--	--	--	--
CU	.0080	--	--	--	--	--
FE	79.	--	100.	--	52.	--
HG	<.00020	--	--	--	--	--
K	2.4	--	2.3	--	1.5	--
MG	90.	--	82.	--	50.	--
MN	2.7	--	3.0	--	1.6	--
MO	<.50	--	--	--	--	--
NA	29.	--	24.	--	15.	--
NI	<.0050	--	--	--	--	--
NO3	--	--	--	--	--	--
PB	<.0020	--	--	--	--	--
PH	7.3	6.7	6.9	6.7	6.9	6.5
PO4	--	--	.020	--	.057	--
SE	<.0010	--	--	--	--	--
SI	15.	--	--	--	--	--
SO4	17.	--	33.	--	23.	--
SR	.19	--	--	--	--	--
TH	<.0050	--	--	--	--	--
TI	<1.0	--	--	--	--	--
V	<.50	--	--	--	--	--
ZN	<.020	--	--	--	--	--

*TBTGS data on fresh samples taken on the previous date to that shown.

FUEL STORAGE AREA GROUNDWATER QUALITY-TBTGS-1983

LOCATION : 168

TEST	830602	830603*	830726	830727*	830921	830922*
			SAMPLING DATE			
ACIDB.3	--	--	--	--	--	--
AG	<.00020	--	--	--	--	--
AL	<.50	--	--	--	--	--
ALKCO3	<5.0	--	<5.0	--	<5.0	--
ALKHCO3	770.	--	720.	--	640.	--
ALKOH	<5.0	--	<5.0	--	<5.0	--
ALKTOT	--	940.	--	960.	--	810.
AS	.0020	--	--	--	--	--
B	.14	--	.090	--	.26	--
BA	.15	--	--	--	--	--
BE	<.00020	--	--	--	--	--
CA	100.	--	110.	--	57.	--
CD	<.00010	--	--	--	--	--
CL	35.	--	42.	--	37.	--
CO	.0040	--	--	--	--	--
COND	140.	190.	140.	170.	130.	140.
CR	.011	--	--	--	--	--
CU	.0070	--	--	--	--	--
FE	68.	--	120.	--	62.	--
HG	<.00020	--	--	--	--	--
K	7.7	--	7.3	--	4.1	--
MG	57.	--	61.	--	31.	--
MN	1.6	--	2.2	--	.89	--
MO	<.50	--	--	--	--	--
NA	150.	--	91.	--	38.	--
NI	<.0050	--	--	--	--	--
NO3	--	--	--	--	--	--
PB	<.0020	--	--	--	--	--
PH	6.9	6.4	6.8	6.6	6.7	6.5
PO4	--	--	.080	--	.031	--
SE	<.0010	--	--	--	--	--
SI	13.	--	--	--	--	--
SO4	10.	--	1.7	--	.70	--
SR	.24	--	--	--	--	--
TH	<.0050	--	--	--	--	--
TI	<1.0	--	--	--	--	--
V	<.50	--	--	--	--	--
ZN	<.020	--	--	--	--	--

*TBTGS data on fresh samples taken on the previous date to that shown.

FUEL STORAGE AREA GROUNDWATER QUALITY-TBTGS-1983

LOCATION : 17A

TEST	830602	830603*	830726	830727*	830921	830922*
	SAMPLING DATE					
ACIDB.3	--	--	--	--	--	--
AG	<.00020	--	--	--	--	--
AL	<.50	--	--	--	--	--
ALKCO3	<5.0	--	<5.0	--	<5.0	--
ALKHCO3	540.	--	530.	--	650.	--
ALKOH	<5.0	--	<5.0	--	<5.0	--
ALKTOT	--	860.	--	930.	--	830.
AS	.0030	--	--	--	--	--
B	.060	--	.48	--	.39	--
BA	.22	--	--	--	--	--
BE	<.00020	--	--	--	--	--
CA	270.	--	260.	--	160.	--
CD	.00010	--	--	--	--	--
CL	73.	--	98.	--	89.	--
CO	.027	--	--	--	--	--
COND	230.	340.	220.	290.	220.	260.
CR	.013	--	--	--	--	--
CU	.036	--	--	--	--	--
FE	120.	--	200.	--	120.	--
HG	<.00020	--	--	--	--	--
K	7.3	--	6.8	--	4.6	--
MG	120.	--	110.	--	68.	--
MN	2.9	--	3.5	--	1.9	--
MO	<.50	--	--	--	--	--
NA	100.	--	91.	--	52.	--
NI	<.0050	--	--	--	--	--
NO3	--	--	--	--	--	--
PB	<.0020	--	--	--	--	--
PH	6.7	6.2	6.6	6.5	6.6	6.3
PO4	--	--	<.0050	--	.058	--
SE	<.0010	--	--	--	--	--
SI	12.	--	--	--	--	--
SO4	720.	--	620.	--	600.	--
SR	.27	--	--	--	--	--
TH	<.0050	--	--	--	--	--
TI	<1.0	--	--	--	--	--
V	<.50	--	--	--	--	--
ZN	<.020	--	--	--	--	--

*TBTGS data on fresh samples taken on the previous date to that shown.

FUEL STORAGE AREA GROUNDWATER QUALITY-TBTGS-1983

LOCATION : 17B

TEST	830602	830603*	830726	830727*	830921	830922*
			SAMPLING DATE			
ACID8.3	--	--	--	--	--	--
AG	<.00020	--	--	--	--	--
AL	<.50	--	--	--	--	--
ALKCO3	--	--	<5.0	--	<5.0	--
ALKHCO3	--	--	910.	--	820.	--
ALKOH	--	--	<5.0	--	<5.0	--
ALKTOT	--	--	--	1100.	--	1000.
AS	.0020	--	--	--	--	--
B	--	--	.37	--	.53	--
BA	.10	--	--	--	--	--
BE	<.00020	--	--	--	--	--
CA	100.	--	100.	--	75.	--
CD	<.00010	--	--	--	--	--
CL	--	--	87.	--	85.	--
CO	.010	--	--	--	--	--
COND	--	220.	190.	250.	170.	230.
CR	.011	--	--	--	--	--
CU	.011	--	--	--	--	--
FE	76.	--	69.	--	67.	--
HG	<.00020	--	--	--	--	--
K	18.	--	18.	--	12.	--
MG	49.	--	46.	--	31.	--
MN	3.0	--	3.6	--	2.0	--
MO	<.50	--	--	--	--	--
NA	220.	--	220.	--	95.	--
NI	.0050	--	--	--	--	--
NO3	--	--	--	--	--	--
PB	<.0020	--	--	--	--	--
PH	--	6.7	7.0	6.6	6.9	6.4
PO4	--	--	.080	--	.13	--
SE	<.0010	--	--	--	--	--
SI	--	--	--	--	--	--
SO4	--	--	75.	--	61.	--
SR	.26	--	--	--	--	--
TH	<.0050	--	--	--	--	--
TI	<1.0	--	--	--	--	--
V	<.50	--	--	--	--	--
ZN	<.020	--	--	--	--	--

*TBTGS data on fresh samples taken on the previous date to that shown.

FUEL STORAGE AREA GROUNDWATER QUALITY-TBTGS-1983

LOCATION : 18A

TEST	830602	830603*	830726	830727*	830921	830922*
	SAMPLING DATE					
ACIDB.3	490.	--	--	--	590.	--
AG	<.00020	--	--	--	--	--
AL	<.50	--	--	--	--	--
ALKCO3	--	--	<5.0	--	<5.0	--
ALKHCO3	--	--	<5.0	--	11.	--
ALKOH	--	--	<5.0	--	<5.0	--
ALKTOT	--	110.	--	170.	--	90.
AS	<.0010	--	--	--	--	--
B	1.7	--	2.4	--	3.0	--
BA	<.10	--	--	--	--	--
BE	<.00020	--	--	--	--	--
CA	340.	--	350.	--	240.	--
CD	.00010	--	--	--	--	--
CL	27.	--	28.	--	30.	--
CO	.19	--	--	--	--	--
COND	330.	380.	320.	350.	350.	360.
CR	.011	--	--	--	--	--
CU	.0050	--	--	--	--	--
FE	100.	--	410.	--	260.	--
HG	<.00020	--	--	--	--	--
K	5.7	--	6.3	--	4.4	--
MG	150.	--	150.	--	96.	--
MN	76.	--	80.	--	4.8	--
MO	<.50	--	--	--	--	--
NA	110.	--	110.	--	73.	--
NI	<.0050	--	--	--	--	--
NO3	10.	--	--	--	--	--
PB	<.0020	--	--	--	--	--
PH	4.0	6.3	5.5	6.2	5.2	6.2
PO4	--	--	<.0050	--	<.0050	--
SE	<.0010	--	--	--	--	--
SI	27.	--	--	--	--	--
SO4	2200.	--	2300.	--	2400.	--
SR	.66	--	--	--	--	--
TH	<.0050	--	--	--	--	--
TI	<1.0	--	--	--	--	--
V	<.50	--	--	--	--	--
ZN	<.020	--	--	--	--	--

*TBTGS data on fresh samples taken on the previous date to that shown.

FUEL STORAGE AREA GROUNDWATER QUALITY-TBTGS-1983

LOCATION : 18B

TEST	830602	830603*	830726	830727*	830921	830922*
	SAMPLING DATE					
ACIDB.3	160.	--	--	--	150.	--
AG	<.00020	--	--	--	--	--
AL	<.50	--	--	--	--	--
ALKCO3	--	--	<5.0	--	<5.0	--
ALKHCO3	--	--	25.	--	49.	--
ALKOH	--	--	<5.0	--	<5.0	--
ALKTOT	--	90.	--	170.	--	130.
AS	<.0010	--	--	--	--	--
B	1.5	--	1.8	--	2.1	--
BA	<.10	--	--	--	--	--
BE	<.00020	--	--	--	--	--
CA	230.	--	230.	--	120.	--
CD	.00010	--	--	--	--	--
CL	17.	--	17.	--	30.	--
CO	.020	--	--	--	--	--
COND	210.	260.	200.	240.	210.	230.
CR	.0090	--	--	--	--	--
CU	.050	--	--	--	--	--
FE	89.	--	130.	--	63.	--
HG	<.00020	--	--	--	--	--
K	4.6	--	5.2	--	3.0	--
MG	93.	--	88.	--	46.	--
MN	46.	--	42.	--	2.2	--
MO	<.50	--	--	--	--	--
NA	86.	--	88.	--	52.	--
NI	<.0050	--	--	--	--	--
NO3	<5.0	--	--	--	--	--
PB	<.0020	--	--	--	--	--
PH	4.2	6.4	6.2	6.3	5.9	6.0
PO4	--	--	<.0050	--	.046	--
SE	<.0010	--	--	--	--	--
SI	20.	--	--	--	--	--
SO4	1300.	--	1200.	--	920.	--
SR	.24	--	--	--	--	--
TH	<.0050	--	--	--	--	--
TI	<1.0	--	--	--	--	--
V	<.50	--	--	--	--	--
ZN	<.020	--	--	--	--	--

*TBTGS data on fresh samples taken on the previous date to that shown.

FUEL STORAGE AREA GROUNDWATER QUALITY-TBTGS-1983

LOCATION : 19A

TEST	SAMPLING DATE 830602	830603*	830726	830727*	830921	830922*
ACID8.3	500.	--	--	--	700.	--
AG	<.00020	--	--	--	--	--
AL	<.50	--	--	--	--	--
ALKCO3	--	--	<5.0	--	<5.0	--
ALKHCO3	--	--	<5.0	--	8.0	--
ALKOH	--	--	<5.0	--	<5.0	--
ALKTOT	--	50.	--	160.	--	60.
AS	<.0010	--	--	--	--	--
B	.83	--	1.6	--	2.2	--
BA	<.10	--	--	--	--	--
BE	<.00020	--	--	--	--	--
CA	290.	--	330.	--	190.	--
CD	.00010	--	--	--	--	--
CL	40.	--	45.	--	29.	--
CO	.022	--	--	--	--	--
COND	380.	410.	390.	440.	390.	400.
CR	.016	--	--	--	--	--
CU	.0050	--	--	--	--	--
FE	430.	--	530.	--	290.	--
HG	<.00020	--	--	--	--	--
K	3.0	--	4.2	--	3.4	--
MG	180.	--	200.	--	110.	--
MN	61.	--	74.	--	3.8	--
MO	<.50	--	--	--	--	--
NA	210.	--	200.	--	130.	--
NI	<.0050	--	--	--	--	--
NO3	11.	--	--	--	--	--
PB	<.0020	--	--	--	--	--
PH	3.9	6.0	5.2	6.4	5.0	6.1
PO4	--	--	.12	--	<.0050	--
SE	<.0010	--	--	--	--	--
SI	28.	--	--	--	--	--
SO4	2700.	--	2800.	--	2500.	--
SR	.26	--	--	--	--	--
TH	<.0050	--	--	--	--	--
TI	<1.0	--	--	--	--	--
V	<.50	--	--	--	--	--
ZN	<.020	--	--	--	--	--

*TBTGS data on fresh samples taken on the previous date to that shown.

FUEL STORAGE AREA GROUNDWATER QUALITY-TBTGS-1983

LOCATION : 19B

TEST	830602	830603*	830726	830727*	830921	830922*
	SAMPLING DATE					
ACID8.3	--	--	--	--	650.	--
AG	<.00020	--	--	--	--	--
AL	<.50	--	--	--	--	--
ALKCO3	--	--	<5.0	--	<5.0	--
ALKHCO3	--	--	<5.0	--	<5.0	--
ALKOH	--	--	<5.0	--	<5.0	--
ALKTOT	--	--	--	40.	--	60.
AS	<.0010	--	--	--	--	--
B	--	--	2.2	--	2.6	--
BA	<.10	--	--	--	--	--
BE	.0024	--	--	--	--	--
CA	430.	--	470.	--	220.	--
CD	.0041	--	--	--	--	--
CL	--	--	31.	--	29.	--
CO	.80	--	--	--	--	--
COND	--	470.	430.	490.	430.	420.
CR	.018	--	--	--	--	--
CU	.11	--	--	--	--	--
FE	270.	--	330.	--	170.	--
HG	.00060	--	--	--	--	--
K	11.	--	13.	--	7.4	--
MG	200.	--	200.	--	100.	--
MN	93.	--	110.	--	5.3	--
MO	<.50	--	--	--	--	--
NA	220.	--	230.	--	140.	--
NI	500.	--	--	--	--	--
NO3	--	--	--	--	--	--
PB	<.0020	--	--	--	--	--
PH	--	5.1	4.6	5.6	4.3	5.1
PO4	--	--	<.0050	--	.21	--
SE	<.0010	--	--	--	--	--
SI	--	--	--	--	--	--
SO4	--	--	3200.	--	2400.	--
SR	1.6	--	--	--	--	--
TH	<.0050	--	--	--	--	--
TI	<1.0	--	--	--	--	--
V	<.50	--	--	--	--	--
ZN	<.020	--	--	--	--	--

*TBTGS data on fresh samples taken on the previous date to that shown.

APPENDIX B

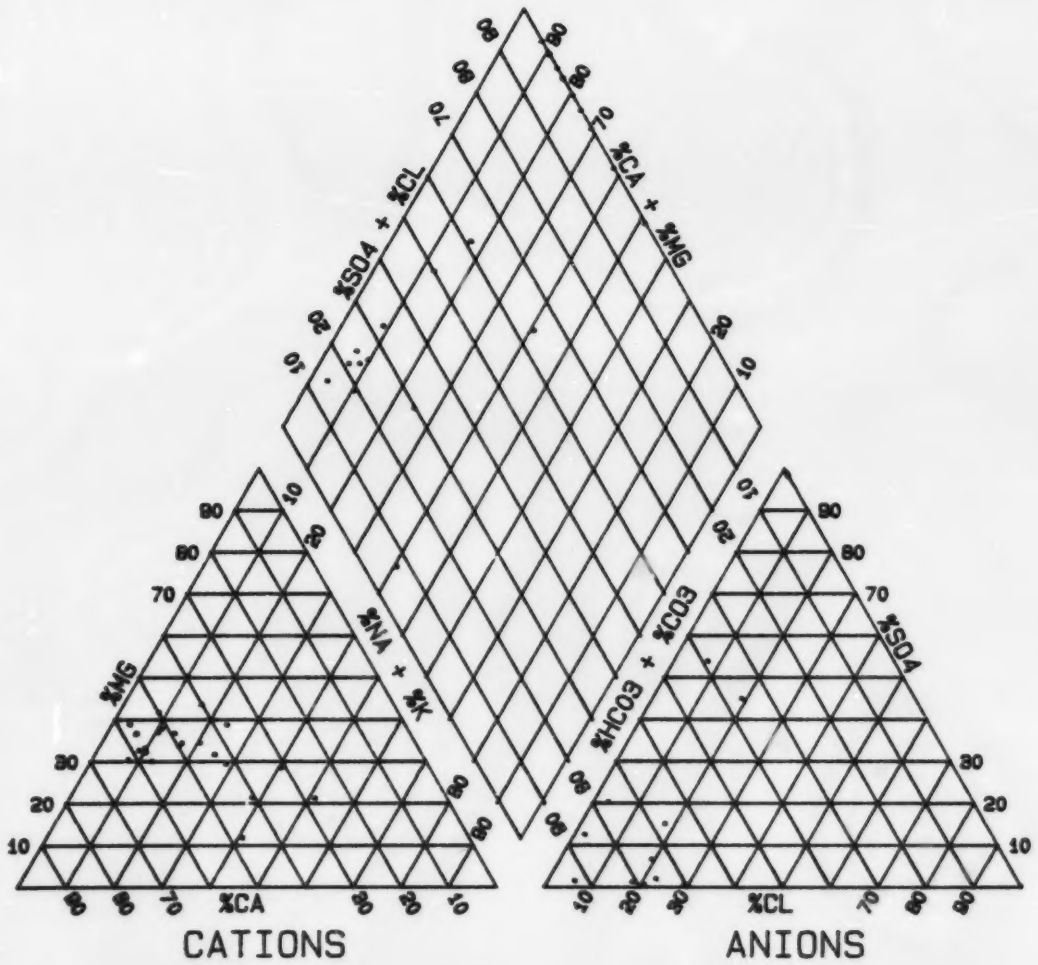
POST-OPERATIONAL FUEL STORAGE
AREA GROUNDWATER QUALITY STUDIES
1983
THUNDER BAY TGS EXTENSION

ION BALANCES

AND

PIPER DIAGRAMS

MAJOR ION CHEMISTRY
TBTGS FUEL
JUNE 02 1983
TYPE - WATER
FUEL STORAGE AREA GROUNDWATER QUALITY-TBTGS-1983



MAJOR ION CHEMISTRY

TBTGS FUEL
JUNE 02 1983
TYPE - WATER

FUEL STORAGE AREA GROUNDWATER QUALITY-TBTGS-1983

	CATIONS												CATION TOTAL	ANION TOTAL
	CA			MG			NA			K				
LOCATION	MG/L	EPM	%EPM	MG/L	EPM	%EPM	MG/L	EPM	%EPM	MG/L	EPM	%EPM	EPM	EPM
01A	79	3.94	43	35	2.88	32	52	2.26	25	2	.05	1	9.13	9.66
04A	87	4.34	50	44	3.62	42	14	.61	7	6	.14	2	8.71	9.16
05C	270	13.47	57	95	7.82	33	52	2.26	10	4	.10	0	23.65	24.57
06B	214	10.67	57	68	5.60	30	54	2.35	13	3	.09	0	18.70	20.40
06C	297	14.81	58	100	8.23	32	51	2.22	9	3	.07	0	25.33	25.05
07B	118	5.89	57	40	3.29	32	24	1.04	10	2	.05	0	10.27	10.14
08B	44	2.19	47	7	.54	12	42	1.83	39	3	.08	2	4.64	4.59
12C	322	16.06	62	96	7.90	30	43	1.87	7	7	.18	1	26.01	29.62*
13B	410	20.45	52	174	14.32	37	92	4.00	10	8	.20	1	38.97	60.97*
13C	399	19.90	51	178	14.65	38	95	4.13	11	8	.21	1	38.89	56.92*
14A	424	21.15	40	280	23.05	43	200	8.70	16	4	.11	0	53.00	74.36*
14B	220	10.97	42	93	7.65	29	171	7.43	28	5	.12	0	26.18	31.56*
14C	123	6.13	41	39	3.21	21	132	5.74	38	2	.06	0	15.14	.00*
15A	221	11.02	57	85	7.00	36	27	1.17	6	2	.05	0	19.24	18.82
15B	273	13.62	57	112	9.22	39	17	.74	3	8	.20	1	23.78	23.47
16A	231	11.52	57	90	7.41	37	29	1.26	6	2	.06	0	20.25	19.86
16B	103	5.14	31	57	4.69	28	151	6.57	40	8	.20	1	16.59	16.59
17A	272	13.57	49	116	9.55	34	105	4.57	16	7	.19	1	27.87	27.84
17B	105	5.24	27	49	4.03	21	216	9.39	49	18	.46	2	19.12	.00*
18A	338	16.86	49	153	12.59	37	110	4.78	14	6	.15	0	34.38	46.55*
18B	228	11.37	50	93	7.65	33	86	3.74	16	5	.12	1	22.88	27.53*
19A	286	14.26	37	180	14.81	39	213	9.26	24	4	.10	0	38.44	57.32*
19B	432	21.55	45	200	16.46	34	223	9.70	20	11	.28	1	47.98	.00*

* INDICATES ANION AND CATION TOTALS DON'T LIE WITHIN 10% OF EACH OTHER.

+ INDICATES A MAJOR PARAMETER IS MISSING.

MAJOR ION CHEMISTRY

TBTGS FUEL
JUNE 02 1983
TYPE - WATER

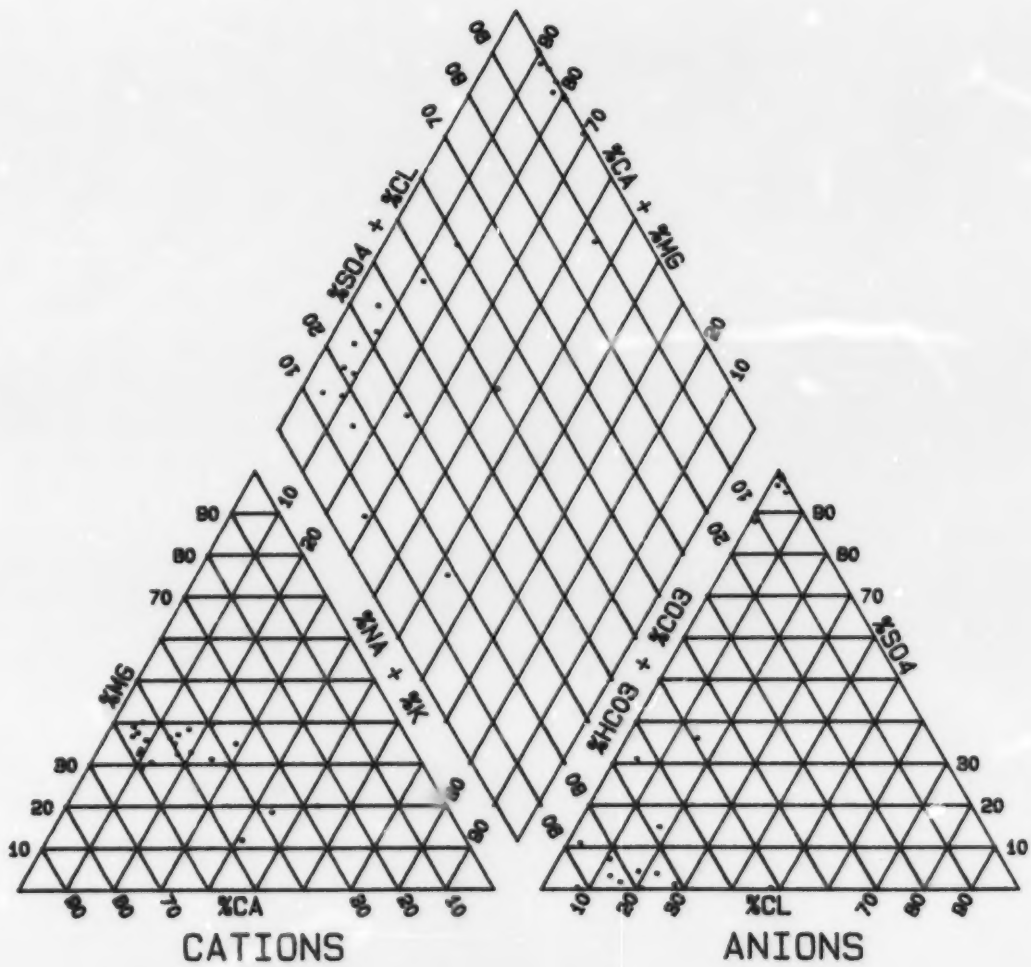
FUEL STORAGE AREA GROUNDWATER QUALITY-TBTGS-1983

	ANIONS												ANION TOTAL	CATION TOTAL	ACID4.5	ACID8.3
	CL			SO4			HCO3			CO3						
LOCATION	MG/L	EPM	%EPM	MG/L	EPM	%EPM	MG/L	EPM	%EPM	MG/L	EPM	%EPM	EPM	EPM	MG/L	MG/L
01A	100	2.82	29	2	.05	0	415	6.80	70	<5.00	.00	0	9.66	9.13		
04A	11	.31	3	89	1.85	20	427	7.00	76	<5.00	.00	0	9.16	8.71		
05C	170	4.79	19	76	1.58	6	1110	18.19	74	<5.00	.00	0	24.57	23.65		
06B	360	10.14	50	3	.06	0	622	10.20	50	<5.00	.00	0	20.40	18.70		
06C	160	4.51	18	180	3.75	15	1025	16.80	67	<5.00	.00	0	25.05	25.33		
07B	65	1.83	18	5	.11	1	500	8.20	81	<5.00	.00	0	10.14	10.27		
08B	31	.87	19	99	2.06	45	101	1.66	36	<5.00	.00	0	4.59	4.64		
12C	17	.48	2	1400	29.14	98	0	.00	0	0	.00	0	29.62	26.01*+	.00	94.00
13B	22	.62	1	2900	60.35	99	0	.00	0	0	.00	0	60.97	38.97*+	.00	480.00
13C	26	.73	1	2700	56.19	99	0	.00	0	0	.00	0	56.92	38.89*+	.00	560.00
14A	54	1.52	2	3500	72.84	98	0	.00	0	0	.00	0	74.36	53.00*+	.00	690.00
14B	12	.34	1	1500	31.22	99	0	.00	0	0	.00	0	31.56	26.18*+	.00	280.00
14C	0	.00	0	0	.00	0	0	.00	0	0	.00	0	.00	15.14*+		
15A	140	3.94	21	4	.08	0	903	14.80	79	<5.00	.00	0	18.82	19.24		
15B	20	.56	2	140	2.91	12	1220	19.99	85	<5.00	.00	0	23.47	23.78		
16A	160	4.51	23	17	.35	2	915	15.00	76	<5.00	.00	0	19.86	20.25		
16B	35	.99	6	10	.21	1	939	15.40	93	<5.00	.00	0	16.59	16.59		
17A	73	2.06	7	720	14.98	54	659	10.80	39	<5.00	.00	0	27.84	27.87		
17B	0	.00	0	0	.00	0	0	.00	0	0	.00	0	.00	19.12*+		
18A	27	.76	2	2200	45.79	98	0	.00	0	0	.00	0	46.55	34.38*+	.00	490.00
18B	17	.48	2	1300	27.06	98	0	.00	0	0	.00	0	27.53	22.88*+	.00	160.00
19A	40	1.13	2	2700	56.19	98	0	.00	0	0	.00	0	57.32	38.44*+	.00	500.00
19B	0	.00	0	0	.00	0	0	.00	0	0	.00	0	.00	47.98*+		

* INDICATES ANION AND CATION TOTALS DON'T LIE WITHIN 10% OF EACH OTHER.

+ INDICATES A MAJOR PARAMETER IS MISSING.

MAJOR ION CHEMISTRY
TBTGS FUEL
JULY 26 1983
TYPE - WATER
FUEL STORAGE AREA GROUNDWATER QUALITY-1983-TBTGS



MAJOR ION CHEMISTRY

TBTGS FUEL
JULY 26 1983
TYPE - WATER

FUEL STORAGE AREA GROUNDWATER QUALITY-TBTGS-1983

	CATIONS												CATION TOTAL	ANION TOTAL
	CA			MG			NA			K				
LOCATION	MG/L	EPM	%EPM	MG/L	EPM	%EPM	MG/L	EPM	%EPM	MG/L	EPM	%EPM	EPM	EPM
01A	81	4.04	44	35	2.88	31	53	2.30	25	2	.06	1	9.28	9.53
03A	117	5.84	48	55	4.53	37	42	1.83	15	2	.06	0	12.24	12.63
04A	135	6.73	54	61	5.02	40	15	.65	5	6	.15	1	12.56	12.77
05C	282	14.06	58	95	7.82	32	50	2.17	9	4	.09	0	24.15	24.28
06B	197	9.83	57	64	5.27	30	50	2.17	13	4	.09	1	17.36	20.48*
06C	280	13.97	57	99	8.15	33	50	2.17	9	3	.07	0	24.36	25.45
07B	111	5.54	58	38	3.13	33	20	.87	9	2	.04	0	9.58	10.18
08B	31	1.54	47	5	.39	12	30	1.30	40	2	.06	2	3.29	3.18
12C	203	10.12	59	60	4.94	29	42	1.83	11	7	.17	1	17.06	16.27
13B	441	22.00	55	173	14.24	36	80	3.48	9	8	.20	1	39.92	52.73*
13C	459	22.89	55	181	14.90	36	91	3.96	9	8	.21	0	41.95	56.90*
14A	452	22.54	45	234	19.26	38	195	8.48	17	4	.11	0	50.39	70.23*
14B	225	11.22	41	99	8.15	30	179	7.78	29	6	.14	1	27.29	33.85*
14C	113	5.64	37	34	2.80	18	153	6.65	44	4	.09	1	15.18	15.43
15A	202	10.07	56	82	6.75	37	26	1.13	6	2	.05	0	18.01	18.54
15B	245	12.22	56	103	8.48	39	20	.87	4	9	.24	1	21.80	22.97
16A	213	10.62	58	82	6.75	37	24	1.04	6	2	.06	0	18.47	19.79
16B	106	5.29	37	61	5.02	35	91	3.96	27	7	.19	1	14.45	15.61
17A	260	12.97	49	111	9.14	35	91	3.96	15	7	.17	1	26.23	26.26
17B	103	5.14	27	46	3.79	20	222	9.65	51	18	.46	2	19.04	22.21*
18A	352	17.56	50	155	12.76	36	110	4.78	14	6	.16	0	35.26	48.66*
18B	226	11.27	50	88	7.24	32	88	3.83	17	5	.13	1	22.47	25.95*
19A	326	16.26	39	200	16.46	40	202	8.78	21	4	.11	0	41.61	59.54*
19B	475	23.69	47	200	16.46	33	227	9.87	20	13	.32	1	50.35	67.47*

* INDICATES ANION AND CATION TOTALS DON'T LIE WITHIN 10% OF EACH OTHER.

+ INDICATES A MAJOR PARAMETER IS MISSING.

MAJOR ION CHEMISTRY

TBTGS FUEL
JULY 26 1983
TYPE - WATER

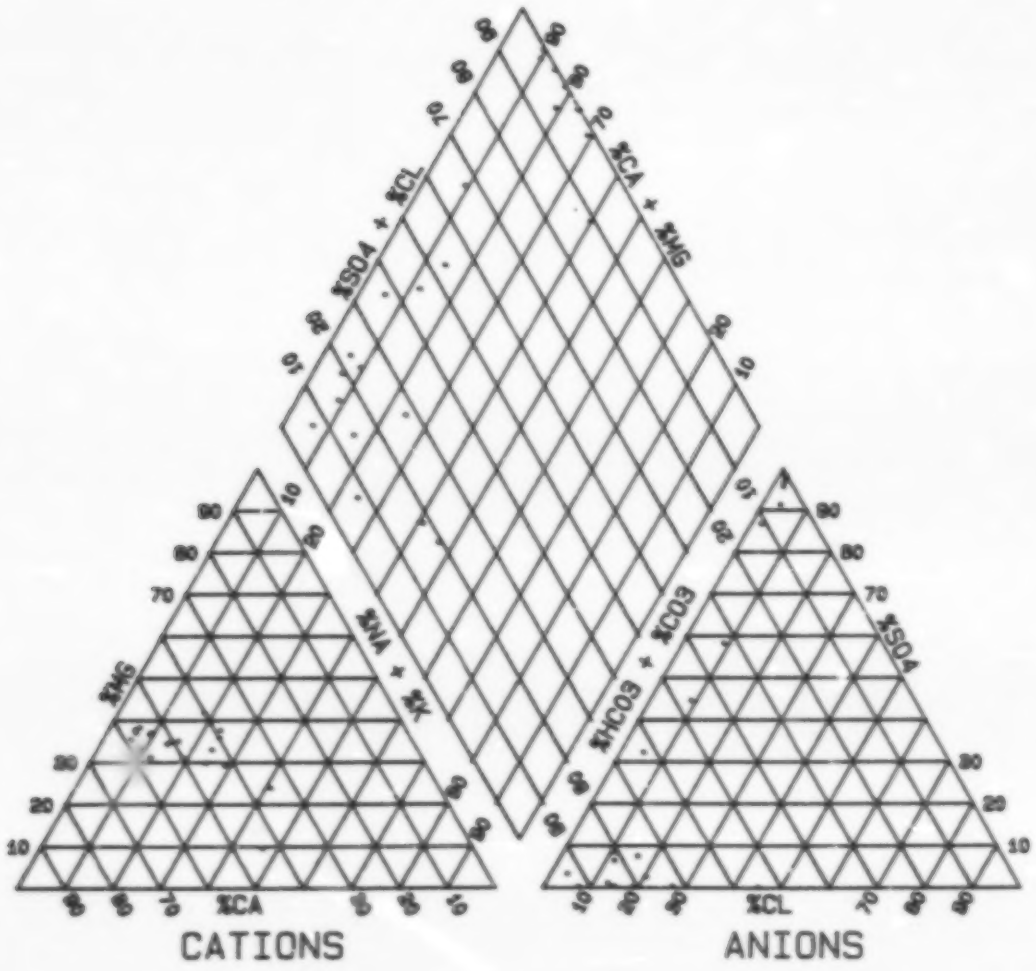
FUEL STORAGE AREA GROUNDWATER QUALITY-TBTGS-1983

	ANIONS												ANION TOTAL	CATION TOTAL	ACID4.5	ACID8.3
	CL			SO4			HCO3			CO3						
LOCATION	MG/L	EPM	%EPM	MG/L	EPM	%EPM	MG/L	EPM	%EPM	MG/L	EPM	%EPM	EPM	EPM	MG/L	MG/L
01A	94	2.65	28	4	.08	1	415	6.80	71	<5.00	.00	0	9.53	9.28		
03A	59	1.66	13	18	.37	3	647	10.60	84	<5.00	.00	0	12.63	12.24		
04A	22	.62	5	190	3.95	31	500	8.20	64	<5.00	.00	0	12.77	12.56		
05C	160	4.51	19	47	.98	4	1147	18.79	77	<5.00	.00	0	24.28	24.15		
06B	350	9.86	48	1	.03	0	647	10.60	52	<5.00	.00	0	20.48	17.36*		
06C	160	4.51	18	180	3.75	15	1049	17.19	68	<5.00	.00	0	25.45	24.36		
07B	58	1.63	16	7	.15	1	512	8.40	82	<5.00	.00	0	10.18	9.58		
08B	17	.48	15	55	1.14	36	95	1.56	49	<5.00	.00	0	3.18	3.29		
12C	25	.70	4	740	15.40	95	10	.17	1	<5.00	.00	0	16.27	17.06		
13B	25	.70	1	2500	52.03	99	<5.00	.00	0	<5.00	.00	0	52.73	39.92*+		
13C	25	.70	1	2700	56.19	99	<5.00	.00	0	<5.00	.00	0	56.90	41.95*+		
14A	55	1.55	2	3300	68.68	98	<5.00	.00	0	<5.00	.00	0	70.23	50.39*+		
14B	14	.39	1	1600	33.30	98	10	.16	0	<5.00	.00	0	33.85	27.29*		
14C	7	.20	1	650	13.53	88	104	1.70	11	<5.00	.00	0	15.43	15.18		
15A	140	3.94	21	<.500	.00	0	891	14.60	79	<5.00	.00	0	18.54	18.01 +		
15B	24	.68	3	120	2.50	11	1208	19.79	86	<5.00	.00	0	22.97	21.80		
16A	160	4.51	23	33	.69	3	891	14.60	74	<5.00	.00	0	19.79	18.47		
16B	42	1.18	8	2	.04	0	878	14.40	92	<5.00	.00	0	15.61	14.45		
17A	98	2.76	11	620	12.90	49	647	10.60	40	<5.00	.00	0	26.26	26.23		
17B	87	2.45	11	75	1.56	7	1110	18.19	82	<5.00	.00	0	22.21	19.04*		
18A	28	.79	2	2300	47.87	98	<5.00	.00	0	<5.00	.00	0	48.66	35.26*+		
18B	17	.48	2	1200	24.97	96	30	.50	2	<5.00	.00	0	25.95	22.47*		
19A	45	1.27	2	2800	58.27	98	<5.00	.00	0	<5.00	.00	0	59.54	41.61*+		
19B	31	.87	1	3200	66.60	99	<5.00	.00	0	<5.00	.00	0	67.47	50.35*+		

* INDICATES ANION AND CATION TOTALS DON'T LIE WITHIN 10% OF EACH OTHER.

+ INDICATES A MAJOR PARAMETER IS MISSING.

MAJOR ION CHEMISTRY
TBTGS FUEL
SEPT 21 1983
TYPE - WATER
FUEL STORAGE AREA GROUNDWATER QUALITY - TBTGS -198



MAJOR ION CHEMISTRY

TBTGS FUEL
SEPT 21 1983
TYPE - WATER

FUEL STORAGE AREA GROUNDWATER QUALITY-TBTGS-1983

	ANIONS												ANION TOTAL	CATION TOTAL	ACID4.5	ACID8.3
	CL			SO4			HCO3			CO3						
LOCATION	MG/L	EPM	%EPM	MG/L	EPM	%EPM	MG/L	EPM	%EPM	MG/L	EPM	%EPM	EPM	EPM	MG/L	MG/L
01A	93	2.62	27	1	.02	0	426	6.98	73	<5.00	.00	0	9.62	5.25*		
03A	57	1.61	13	6	.12	1	633	10.38	86	<5.00	.00	0	12.10	7.76*		
04A	25	.70	5	210	4.37	32	520	8.52	63	<5.00	.00	0	13.59	6.98*		
05C	140	3.94	16	86	1.79	7	1127	18.47	76	<5.00	.00	0	24.21	13.32*		
06B	310	8.73	45	<.500	.00	0	643	10.54	55	<5.00	.00	0	19.27	10.59*+		
06C	100	2.82	9	880	18.31	58	634	10.40	33	<5.00	.00	0	31.53	13.90*		
07B	52	1.46	15	1	.02	0	506	8.30	85	<5.00	.00	0	9.79	6.07*		
08B	9	.26	11	9	.19	8	116	1.90	81	<5.00	.00	0	2.35	1.48*		
12C	24	.68	2	1300	27.06	96	34	.56	2	<5.00	.00	0	28.29	14.81*		
13B	29	.82	1	2700	56.19	98	12	.20	0	<5.00	.00	0	57.21	21.16*		
13C	28	.79	1	2900	60.35	98	12	.20	0	<5.00	.00	0	61.34	21.56*		
14A	51	1.44	2	3000	62.43	97	11	.18	0	<5.00	.00	0	64.05	24.97*		
14B	22	.62	2	1400	29.14	97	23	.38	1	<5.00	.00	0	30.14	18.12*		
14C	11	.31	2	560	11.65	87	90	1.48	11	<5.00	.00	0	13.44	9.23*		
15A	120	3.38	19	1	.02	0	880	14.42	81	<5.00	.00	0	17.82	10.03*		
15B	28	.79	4	34	.71	3	1243	20.37	93	<5.00	.00	0	21.87	13.35*		
16A	140	3.94	21	23	.48	2	900	14.76	77	<5.00	.00	0	19.18	11.59*		
16B	37	1.04	8	1	.01	0	777	12.74	92	<5.00	.00	0	13.79	7.15*		
17A	89	2.51	9	600	12.49	44	798	13.08	47	<5.00	.00	0	28.07	16.06*		
17B	85	2.39	12	61	1.27	6	1002	16.42	82	<5.00	.00	0	20.08	10.72*		
18A	30	.85	2	2400	49.95	98	13	.22	0	<5.00	.00	0	51.01	23.06*		
18B	30	.85	4	920	19.15	91	60	.98	5	<5.00	.00	0	20.97	12.21*		
19A	29	.82	2	2500	52.03	98	10	.16	0	<5.00	.00	0	53.01	24.79*		
19B	29	.82	2	2400	49.95	98	<5.00	.00	0	<5.00	.00	0	50.76	26.27*+	.08	649.00

*= INDICATES ANION AND CATION TOTALS DON'T LIE WITHIN 10% OF EACH OTHER.

+ INDICATES A MAJOR PARAMETER IS MISSING.

MAJOR ION CHEMISTRY

TBTGS FUEL
SEPT 21 1983
TYPE - WATER

FUEL STORAGE AREA GROUNDWATER QUALITY-TBTGS-1983

	CATIONS												CATION TOTAL	ANION TOTAL
	CA			MG			NA			K				
LOCATION	MG/L	EPM	%EPM	MG/L	EPM	%EPM	MG/L	EPM	%EPM	MG/L	EPM	%EPM	EPM	EPM
01A	48	2.39	46	19	1.56	30	29	1.26	24	1	.03	1	5.25	9.62*
03A	76	3.79	49	33	2.72	35	28	1.22	16	2	.04	1	7.76	12.10*
04A	79	3.94	56	32	2.63	38	7	.32	5	3	.09	1	6.98	13.59*
05C	159	7.93	60	50	4.12	31	28	1.22	9	2	.05	0	13.32	24.21*
06B	120	5.99	57	40	3.29	31	29	1.26	12	2	.05	1	10.59	19.27*
06C	160	7.98	57	56	4.61	33	29	1.26	9	2	.05	0	13.90	31.53*
07B	73	3.64	60	23	1.89	31	12	.50	8	1	.03	1	6.07	9.79*
08B	13	.65	44	2	.14	9	15	.65	44	2	.04	3	1.48	2.35*
12C	180	8.98	61	53	4.36	29	31	1.35	9	5	.13	1	14.81	28.29*
13B	226	11.27	53	95	7.82	37	45	1.96	9	5	.12	1	21.16	57.21*
13C	233	11.62	54	96	7.90	37	44	1.91	9	5	.12	1	21.56	61.34*
14A	200	9.98	40	126	10.37	42	105	4.57	18	2	.06	0	24.97	64.05*
14B	152	7.58	42	64	5.27	29	119	5.17	29	4	.10	1	18.12	30.14*
14C	73	3.64	39	23	1.89	21	84	3.65	40	2	.04	0	9.23	13.44*
15A	114	5.69	57	45	3.70	37	14	.61	6	1	.03	0	10.03	17.82*
15B	148	7.38	55	62	5.10	38	15	.65	5	8	.21	2	13.35	21.87*
16A	136	6.78	59	50	4.12	36	15	.65	6	2	.04	0	11.59	19.18*
16B	57	2.84	40	31	2.55	36	38	1.65	23	4	.10	1	7.15	13.79*
17A	162	8.08	50	68	5.60	35	52	2.26	14	5	.12	1	16.06	28.07*
17B	75	3.74	35	31	2.55	24	95	4.13	39	12	.30	3	10.72	20.08*
18A	238	11.87	51	96	7.90	34	73	3.17	14	4	.11	0	23.06	51.01*
18B	122	6.08	50	46	3.79	31	52	2.26	19	3	.08	1	12.21	20.97*
19A	192	9.58	39	113	9.30	38	134	5.83	24	3	.09	0	24.79	53.01*
19B	225	11.22	43	105	8.64	33	143	6.22	24	7	.19	1	26.27	50.76*

* INDICATES ANION AND CATION TOTALS DON'T LIE WITHIN 10% OF EACH OTHER.

+ INDICATES A MAJOR PARAMETER IS MISSING.

APPENDIX C

POST-OPERATIONAL FUEL STORAGE
AREA GROUNDWATER QUALITY STUDIES
1983
THUNDER BAY TGS EXTENSION

ANNUAL METEOROLOGICAL SUMMARY
1983
THUNDER BAY A (AIRPORT)
ONTARIO

(ENVIRONMENT CANADA)

Environment Canada
Atmospheric Environment Service

Environnement Canada
Service de l'environnement atmosphérique

ANNUAL METEOROLOGICAL SUMMARY

1983

SOMMAIRE METEOROLOGIQUE ANNUEL

THUNDER BAY A
ONTARIO

C-2

84-103

UDC: 551.506.1
551.506.3

Canada

ANNUAL METEOROLOGICAL SUMMARY
SOMMAIRE MÉTÉOROLOGIQUE ANNUEL

for/pour THUNDER BAY "A", ONTARIO YEAR/ANNÉE 1983

METEOROLOGICAL DATA FOR THE YEAR / DONNÉES MÉTÉOROLOGIQUE POUR L'ANNÉE

NOTE: The following units are used throughout this summary –
Temperature: Degrees and tenths Celcius (°C)
Degree Day: Difference of Daily Mean Temperature from 18.0°C
Rain: Millimetres and tenths (mm)
Snow: Centimetres and tenths (cm)
Total Precipitation: Millimetres and tenths (mm)
Wind Speed: Kilometres per hour (km/h)
Wind Direction: Direction (true north) from which the wind is blowing.
Barometric Pressure: Kilopascals and hundredths (kPa)
Sunshine: Hours and tenths of bright sunshine.

AVIS: Unités Utilisées –
Température: Degrés et dixième Celsius (°C)
Degré Jour: Différence entre la température moyenne du jour et 18.0°C
Pluie: Millimetres et dixièmes (mm)
Neige: Centimetres et dixièmes (cm)
Précipitation Totale: Millimetres et dixièmes (mm)
Vitesse du vent: Kilomètres par heure (km/h)
Direction du vent: Direction (nord géographique) d'ou le vent souffle.
Pression Barométrique: Kilopascals et centièmes (kPa)
Insolation: Nombre d'heures et dixièmes d'insolation effective

MONTH MOIS	TEMPERATURE / TEMPÉRATURE										DEGREE DAYS DEGRÉS JOURS	
	MEAN / MOYENNE			NORMAL / NORMALE			EXTREME / EXTRÊME					
	MAXIMUM	MINIMUM	MONTHLY MENSUELLES	MAXIMUM	MINIMUM	MEAN MOYENNE	MAXIMUM MAXIMALE	DATE	MINIMUM MINIMALE	DATE	BELOW 18.0°C AU DESSOUS DE 18.0°C	NORMAL NORMALE
JAN/JAN	-5.6	-17.2	-11.4	-9.4	-21.3	-15.4	2.1	9	-29.0	18	911.1	1034.9
FEB/FÉV	-3.3	-12.3	-7.8	-6.2	-19.8	-13.0	4.8	14	-29.4	6,7	722.9	876.5
MAR/MAR	0.1	-8.2	-4.1	-0.2	-12.3	-6.3	7.6	8	-20.4	24	683.7	752.5
APR/AVR	7.1	-4.3	1.4	8.3	-3.3	2.5	21.9	25	-18.4	17	496.5	464.9
MAY/MAI	13.1	0.1	6.6	15.5	2.1	8.8	21.8	18	-5.9	S	353.5	285.6
JUN/JUIN	20.8	7.2	14.0	20.7	7.3	14.0	31.5	22	-0.6	8	132.6	126.1
JUL/JUIL	26.5	12.7	19.6	24.3	10.9	17.6	34.1	14	2.7	5	27.6	44.6
AUG/AOÛT	27.0	13.6	20.3	22.8	9.9	16.4	40.3	7	7.7	9	9.7	72.8
SEPT/SEP	19.3	6.8	13.1	17.0	5.1	11.1	31.4	2	-3.0	23	161.8	210.0
OCT/OCT	10.8	0.2	5.5	11.1	0.3	5.7	20.0	27	-6.7	19	386.4	381.2
NOV/NOV	2.8	-5.1	-1.2	1.9	-7.1	-2.6	12.9	6	-15.0	12	573.7	617.7
DEC/DÉC	-11.2	-22.1	-16.7	-5.8	-16.3	-11.1	-1.1	11	-33.3	19	1074.9	901.1
YEAR ANNÉE	9.0	-2.4	3.3	8.3	-3.7	2.3	40.3	Aug. 7 Aout	-33.3	Dec. 19 Dec.	5534.4	5767.9

MONTH MOIS	PRECIPITATION / PRÉCIPITATIONS													
	MONTHLY / MENSUELLES			NORMAL / NORMALE			EXTREME / EXTRÊME							
							RAIN / PLUIE				SNOW / NEIGE			
	RAINFALL HAUTEUR DE PLUIE	SNOWFALL HAUTEUR DE NEIGE	TOTAL	RAIN PLUIE	SNOW NEIGE	TOTAL	6 HRS	DATE	24 HRS	DATE	6 HRS	DATE	24 HRS	DATE
JAN/JAN	4.0	37.8	37.1	1.9	48.4	40.9	2.4	9	2.6	S	5.0	29	10.8	S
FEB/FÉV	4.8	33.1	34.2	1.9	30.7	28.3	3.6	27	4.8	S	4.0	19	10.4	19
MAR/MAR	32.7	12.8	42.1	13.7	34.2	45.0	15.0	6	27.7	S	3.4	9	4.1	9
APR/AVR	14.1	40.2	59.4	35.4	16.2	50.7	3.7	10	5.5	10	9.4	14	20.6	14
MAY/MAI	47.9	0.0	47.9	69.2	4.2	73.3	10.4	22	20.7	S				
JUN/JUIN	67.9	0.0	67.9	76.6	0.0	76.6	9.4	4	20.7	S				
JUL/JUIL	62.4	0.0	62.4	75.4	0.0	75.4	16.2	3	30.8	S				
AUG/AOÛT	108.0	0.0	108.0	83.1	0.0	83.1	17.8	10	38.9	10				
SEPT/SEP	83.8	TR	83.8	89.1	TR	89.1	19.8	10	26.5	S	TR	S	TR	S
OCT/OCT	66.4	8.3	74.7	51.6	3.3	54.8	9.6	13	16.7	S	7.0	14	8.3	S
NOV/NOV	73.3	30.6	103.7	25.3	29.8	52.9	11.2	20	34.9	S	4.8	21	8.5	S
DEC/DÉC	0.0	46.0	37.7	4.1	46.2	41.7	0.0		0.0		8.6	11	21.8	S
YEAR ANNÉE	565.3	208.8	758.9	527.3	213.0	711.8	19.8	SEP 10	38.9	AUG 10	9.4	APR 14	21.8	DEC S

ANNUAL METEOROLOGICAL SUMMARY
SOMMAIRE MÉTÉOROLOGIQUE ANNUEL

for/pour THUNDER BAY "A", ONTARIO YEAR/ANNÉE: 1983

METEOROLOGICAL DATA FOR THE YEAR / DONNÉES MÉTÉOROLOGIQUE POUR L'ANNÉE

MONTH MOIS	SUNSHINE / INSOLATION				WIND / VENT							
							NORMAL MORMALE		MAX FOR 1 MIN MAX POUR 1 MIN		HIGHEST GUST RAFALE MAXIMUM	
	DURATION IN HOURS DUREE (NOMBRE D'HEURES)	PERCENTAGE OF POSSIBLE POURCENTAGE DU TOTAL POSSIBLE	NO. OF DAYS WITHOUT SUNSHINE NOMBRE DE JOURS SANS SOLEIL	NORMAL NORMALE	AVERAGE SPEED VITESSE MOYENNE	PREVAILING DIRECTION DIRECTION DOMINANTE	SPEED VITESSE	DIRECTION	DIRECTION AND SPEED DIRECTION ET VITESSE	DATE	DIRECTION AND SPEED DIRECTION ET VITESSE	DATE
JAN/JAN	102.8	37.2	12	118.4	11.8	W	14.1	W	W 48	4	W 69	4
FEB/FEV	70.5	24.6	14	146.7	11.9	E	13.5	W	ENE 33	19	NNE 48	2
MAR/MAR	112.8	30.6	13	172.8	14.7	ENE	13.8	E	ENE 46	6	E 69	6
APR/AVR	182.7	44.6	6	215.4	14.0	E	14.9	E	SVRL 37	S	N 59	14
MAY/MAI	284.3	60.4	4	252.2	13.0	E	14.7	E	SVRL 37	S	N 59	30
JUN/JUIN	261.8	54.7	1	262.0	11.3	E	12.4	E	W 35	6	W 70	6
JUL/JUIL	314.9	65.2	0	303.7	10.9	W	11.6	W	SVRL 35	4	SVRL 59	11
AUG/AOÛT	296.2	67.0	2	255.9	9.6	WSW	11.2	W	W 46	19	WSW 61	19
SEPT/SEP	157.1	41.7	3	167.9	11.6	W	12.3	W	SVRL 39	S	W 63	10
OCT/OCT	135.6	40.4	5	127.9	11.2	W	13.4	W	WNW 52	28	WNW 67	28
NOV/NOV	52.1	18.7	16	86.5	16.3	WSW	14.3	W	SVRL 48	24	SW 76	24
DEC/DÉC	117.5	44.8	7	93.4	16.8	W	14.0	W	W 54	24	W 78	24
YEAR ANNÉE	2088.3	46.7	83	2202.8	12.8	W	13.4	W	W 54	Dec. 24	W 78	Dec. 24

MONTH MOIS	BAROMETRIC PRESSURE*/PRESSION BAROMÉTRIQUE*											
	STATION LEVEL / NIVEAU DE LA STATION						SEA LEVEL / NIVEAU DE LA MER					
	MEAN MOYENNE	MAXIMUM MAXIMALE	DATE	MINIMUM MINIMALE	DATE	NORMAL NORMALE	MEAN MOYENNE	MAXIMUM MAXIMALE	DATE	MINIMUM MINIMALE	DATE	NORMAL NORMALE
JAN/JAN	99.41	101.34	18	97.28	10	99.31	101.96	104.02	18	99.69	10	101.86
FEB/FEV	99.37	100.45	21	98.00	13	99.28	101.91	102.97	21	100.44	13	101.81
MAR/MAR	99.32	100.62	29	97.42	S	99.26	101.83	103.17	29	99.83	7	101.75
APR/AVR	99.04	100.32	5	97.11	14	99.07	101.51	102.81	5	99.55	14	101.51
MAY/MAI	99.08	100.49	8	97.81	S	99.09	101.52	102.97	8	100.36	22	101.50
JUN/JUIN	98.98	99.98	27	97.59	30	98.63	101.38	102.42	27	99.95	30	101.32
JUL/JUIL	98.95	100.07	9	96.68	4	99.02	101.33	102.48	9	99.03	4	101.38
AUG/AOÛT	99.21	99.92	9	97.98	7	99.08	101.59	102.37	9	100.29	7	101.45
SEPT SEP	98.98	100.25	13	97.28	6	99.14	101.39	102.79	14	99.62	6	101.53
OCT OCT	99.43	101.06	S	97.40	27	99.08	101.88	103.60	19	99.78	27	101.49
NOV NOV	98.90	101.35	3	94.84	23	99.05	101.37	103.87	3	97.19	24	101.52
DEC DÉC	99.43	101.57	19	97.82	26	99.23	102.01	104.31	19	100.35	26	101.75
YEAR ANNÉE	99.18	101.57	Dec. 19	94.84	Nov. 23	99.13	101.64	104.31	Dec. 19	97.19	Nov. 24	101.57

*1 Kilopascal = 0.29529 inches of mercury / 3.386 kilopascals = 1 inch of mercury
= 0.29529 pouces de mercure / 3.386 kilopascals = 1 pouce de mercure

S = several occurrences

ANNUAL METEOROLOGICAL SUMMARY
SOMMAIRE MÉTÉOROLOGIQUE ANNUEL

for/pour THUNDER BAY "A", ONTARIO YEAR/ANNÉE: 1983

METEOROLOGICAL DATA FOR THE YEAR / DONNÉES MÉTÉOROLOGIQUE POUR L'ANNÉE												
DAILY MAXIMUM TEMPERATURES / TEMPERATURES MAXIMALES QUOTIDIENNES												
DATE	JAN JAN	FEB FEV	MAR MAR	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOÛT	SEPT SEP	OCT OCT	NOV NOV	DEC DEC
1	-5.6	-4.3	-7.6	2.3	10.1	19.9	21.1	29.3	30.1	19.8	12.6	-5.9
2	-11.7	-8.2	-2.4	8.2	16.3	21.6	16.0	29.9	31.4	14.4	10.9	-8.1
3	-3.9	-13.1	-1.5	6.2	14.5	16.0	24.2	27.5	29.5	10.6	1.9	-2.3
4	0.5	-12.9	0.6	7.3	8.5	10.4	18.8	24.8	26.7	8.3	6.1	-1.7
5	-1.8	-12.4	5.1	7.9	11.4	16.7	20.7	33.2	23.9	14.4	11.1	-7.4
6	-0.1	-14.2	5.0	4.0	8.6	19.4	24.1	31.0	22.7	10.0	12.9	-10.9
7	-4.9	-7.7	4.3	7.8	12.2	17.0	30.6	40.3	22.1	7.3	10.1	-9.0
8	-1.7	-10.4	7.6	9.3	9.5	10.2	26.6	26.3	26.0	11.2	10.0	-7.9
9	2.1	-9.5	-5.5	7.5	8.7	15.9	21.4	21.1	21.7	15.3	2.1	-15.6
10	2.0	-3.5	-1.9	3.8	14.8	20.6	20.2	16.8	24.0	12.0	-1.5	-11.0
11	-4.0	-1.6	-0.4	8.8	16.0	29.4	33.8	23.8	18.0	13.9	-1.1	-1.1
12	-9.1	0.3	5.1	3.2	15.1	22.1	30.7	26.6	16.0	5.3	1.2	-2.0
13	-10.2	3.6	3.2	2.6	18.0	26.7	33.4	27.4	13.8	6.4	1.2	-7.3
14	-10.0	4.8	2.1	0.3	11.7	23.8	34.1	29.3	15.8	5.7	2.7	-6.8
15	-13.4	1.7	1.2	-2.1	6.7	21.7	24.8	27.1	15.0	6.9	3.9	-9.1
16	-9.9	3.3	-0.3	-2.4	8.9	16.8	25.8	28.1	15.1	11.7	0.8	-16.8
17	-16.4	2.1	1.4	-0.3	16.1	16.1	29.3	26.5	13.3	8.7	0.2	-19.9
18	-17.4	-4.7	0.1	1.8	21.8	21.0	29.1	29.2	17.6	6.2	3.1	-24.4
19	-5.3	-3.1	-4.4	5.7	12.1	19.4	27.7	30.0	12.8	7.7	5.2	-22.2
20	-2.5	0.1	-3.6	8.0	10.5	21.0	29.8	22.7	13.7	9.4	5.6	-18.6
21	-3.2	-2.1	-5.9	11.7	11.8	21.9	24.9	18.6	10.0	10.8	0.6	-5.9
22	-1.3	3.6	-4.8	11.7	12.4	31.5	27.1	24.3	9.4	9.6	-1.4	-10.1
23	0.5	0.9	-6.6	11.3	19.7	28.6	26.4	26.6	14.7	11.2	7.1	-21.5
24	-1.1	-4.4	-4.7	11.8	11.3	29.3	25.3	24.2	16.7	13.4	-1.3	-20.1
25	-14.4	-4.4	2.3	21.9	13.3	25.2	29.3	29.2	24.1	10.5	-3.3	-15.4
26	-15.9	1.2	5.9	13.5	13.3	22.8	28.8	29.6	23.5	12.4	-2.7	-8.2
27	-6.3	2.5	2.4	11.6	15.9	17.4	31.8	29.9	18.1	20.0	-1.3	-11.0
28	-0.3	-1.0	1.2	12.9	7.8	21.3	28.2	28.8	22.8	8.0	-3.1	-13.1
29	1.2		2.4	7.6	14.5	18.8	31.2	22.1	17.2	8.4	-4.2	-15.8
30	-1.4		0.7	10.4	14.6	20.3	21.8	24.7	12.4	13.2	-4.3	-8.0
31	-7.0		2.7		19.2		23.9	27.4		12.8		-10.4

ANNUAL METEOROLOGICAL SUMMARY
SOMMAIRE MÉTÉOROLOGIQUE ANNUEL

for/pour THUNDER BAY "A", ONTARIO YEAR/ANNÉE: 1983

METEOROLOGICAL DATA FOR THE YEAR/DONNÉES MÉTÉOROLOGIQUE POUR L'ANNÉE													
NUMBER OF DAYS WITH: NOMBRE DE JOURS AVEC:	JAN JAN	FEB FÉV	MAR MAR	APR AVR	MAY MAI	JUN JUIL	JUL JUIL	AUG AOÛT	SEPT SEP	OCT OCT	NOV NOV	DEC DÉC	YEAR ANNÉE
MEASURABLE RAIN PLUIE, MESURABLE	3	2	7	4	8	13	10	9	17	17	5	0	95
RAIN (Trace or More) PLUIE (Trace ou davantage)	5	5	10	5	14	15	11	13	18	19	9	0	124
MEASURABLE SNOW NEIGE, MESURABLE	14	10	7	6	0	0	0	0	0	2	10	11	60
SNOW (Trace or More) NEIGE (Trace ou davantage)	23	16	13	8	0	0	0	0	2	3	18	22	105
MEASURABLE PRECIPITATION PRÉCIPITATION, MESURABLE	14	10	12	8	8	13	10	9	17	17	10	9	137
PRECIPITATION (Trace or More) PRÉCIPITATION (Trace ou davantage)	23	17	17	10	14	15	11	13	18	19	20	22	199
THUNDERSTORMS ORAGES	0	0	0	0	0	3	7	4	6	2	0	0	22
HAIL GRÊLE	0	0	0	0	0	0	0	1	0	0	0	0	1
ICE PELLETS GRANULES DE GLACE	1	1	2	1	0	0	0	0	2	2	1	0	10
FREEZING PRECIPITATION PRECPITATION VERGLACANTE	3	3	2	0	0	0	0	0	0	0	2	0	10
FOG* BROUILLARD*	3	2	5	1	2	5	3	3	5	4	0	0	33
MAXIMUM TEMPERATURE TEMPÉRATURE MAXIMALE 30°C OR MORE/OU PLUS	0	0	0	0	0	1	7	4	2	0	0	0	14
MAXIMUM TEMPERATURE TEMPÉRATURE MAXIMALE 0°C OR LESS/OU MOINS	26	17	13	3	0	0	0	0	0	0	10	31	100
MINIMUM TEMPERATURE TEMPÉRATURE MINIMALE 0°C OR LESS/OU MOINS	31	28	27	28	19	1	0	0	3	16	26	31	210
MINIMUM TEMPERATURE TEMPÉRATURE MINIMALE 15°C OR LESS/OU MOINS	22	11	6	2	0	0	0	0	0	0	1	27	69

*NOTE Fog is only counted when the visibility is restricted to ½ mile or less

*NOTE Le brouillard n'est compté que lorsque la visibilité est ½ mille ou moins

ANNUAL METEOROLOGICAL SUMMARY
SOMMAIRE MÉTÉOROLOGIQUE ANNUEL

for/pour THUNDER BAY "A", ONTARIO YEAR/ANNÉE: 1983

METEOROLOGICAL DATA FOR THE YEAR / DONNÉES MÉTÉOROLOGIQUE POUR L'ANNÉE

DAILY MINIMUM TEMPERATURES / TEMPERATURES MINIMALES QUOTIDIENNES

DATE	JAN JAN	FEB FEV	MAR MAR	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOÛT	SEPT SEP	OCT OCT	NOV NOV	DEC DEC
1	-18.0	-20.9	-14.8	-2.3	-3.5	0.9	13.7	15.6	11.4	11.2	2.9	-14.4
2	-27.6	-16.7	-8.5	-4.4	-2.7	2.8	11.8	15.0	16.6	8.2	-1.1	-19.1
3	-17.5	-20.0	-3.9	1.1	-2.9	6.3	11.3	17.9	17.3	6.5	-8.0	-21.8
4	-4.2	-26.3	-2.9	-1.4	-0.2	8.1	4.1	16.1	10.5	4.3	-9.4	-12.4
5	-5.2	-24.0	0.1	-2.7	-5.0	7.0	2.7	15.1	12.7	5.4	-6.8	-20.2
6	-5.0	-29.4	2.1	-0.2	-3.7	2.9	4.6	17.5	10.6	1.0	-0.6	-22.3
7	-16.7	-29.4	1.2	-1.2	-0.1	2.5	11.0	13.0	10.0	1.2	-4.4	-22.5
8	-19.4	-18.4	-6.6	-4.5	-3.4	-0.6	14.6	11.3	6.9	-2.1	1.5	-20.8
9	-2.0	-17.4	-10.4	-7.0	-5.9	4.0	8.6	7.7	16.6	-2.0	-4.7	-27.4
10	-4.0	-9.8	-14.6	0.8	-2.5	1.5	9.4	14.3	13.0	6.5	-8.4	-26.9
11	-22.0	-5.7	-16.1	-3.8	-1.0	7.2	12.5	9.5	6.1	5.0	-12.0	-11.6
12	-24.1	-5.7	-10.0	-3.9	-0.3	10.1	15.5	10.5	3.9	2.6	-15.0	-18.4
13	-23.4	-0.8	-3.7	-0.1	5.5	11.0	12.0	9.0	0.4	0.9	-12.0	-16.8
14	-25.2	-1.1	-5.4	-6.5	-1.5	13.0	16.6	16.2	0.8	-3.5	0.0	-9.1
15	-25.3	-2.2	-5.0	-8.0	-4.9	8.6	16.0	12.5	1.1	-5.2	-0.1	-19.2
16	-18.4	-0.3	-3.4	-14.0	-5.7	8.6	15.0	14.0	8.0	4.5	-3.7	-22.5
17	-25.9	-8.9	-2.4	-18.4	-5.9	7.4	17.2	15.5	2.3	-3.2	-5.7	-27.6
18	-29.0	-9.7	-5.6	-16.4	1.2	5.3	15.0	14.4	8.3	-4.7	-0.2	-31.9
19	-28.0	-8.0	-9.2	-12.7	7.3	4.9	15.8	16.3	7.0	-6.7	1.3	-33.3
20	-18.2	-5.2	-13.4	-6.3	5.0	5.9	14.0	12.9	3.3	-2.7	0.2	-30.3
21	-19.9	-4.8	-17.2	-1.4	4.3	12.1	13.2	14.1	2.2	-5.0	-4.1	-23.9
22	-18.0	-2.9	-16.6	-1.1	4.7	11.9	9.9	12.0	-1.5	0.4	-4.1	-23.4
23	-5.2	-8.4	-15.6	-2.4	4.6	13.7	13.6	10.6	-3.0	-2.9	-2.4	-27.6
24	-15.2	-14.1	-20.4	-3.0	0.8	13.3	13.5	10.6	-2.3	-0.9	-6.7	-24.3
25	-24.3	-19.9	-16.0	-1.6	-2.1	14.1	11.4	14.0	2.2	0.8	-8.0	-27.2
26	-24.4	-18.4	-9.7	-1.7	-1.4	8.9	12.8	17.2	4.7	-1.0	-10.5	-17.8
27	-27.6	-1.0	-4.1	-1.3	-1.6	4.1	14.4	15.6	2.5	0.6	-10.4	-21.2
28	-6.6	-13.6	-8.4	-2.4	5.2	5.0	17.0	13.9	12.0	-0.7	-5.4	-22.8
29	-1.4		-10.4	-0.2	6.2	4.0	16.8	14.4	10.8	-4.4	-6.2	-26.3
30	-11.6		-3.0	-1.1	7.9	12.6	14.0	13.1	10.2	-5.5	-8.2	-19.7
31	-18.8		0.0		3.8		15.8	10.7		-2.6		-21.6

ANNUAL METEOROLOGICAL SUMMARY
SOMMAIRE MÉTÉOROLOGIQUE ANNUEL

for/pour THUNDER BAY "A", ONTARIO YEAR/ANNÉE: 1983

METEOROLOGICAL DATA FOR THE YEAR / DONNÉES MÉTÉOROLOGIQUE POUR L'ANNÉE												
DAILY MEAN TEMPERATURES / TEMPERATURES MOYENNES QUOTIDIENNES												
DATE	JAN JAN	FEB FEV	MAR MAR	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOÛT	SEPT SEP	OCT OCT	NOV NOV	DEC DEC
1	-11.8	-12.6	-11.2	0.0	3.3	10.4	17.4	22.5	20.8	15.5	7.8	-10.2
2	-19.7	-12.5	-5.5	1.9	6.8	12.2	13.9	22.5	24.0	11.3	4.9	-13.6
3	-10.7	-16.6	-2.7	3.7	5.8	11.2	17.8	22.7	23.4	8.6	-3.1	-12.1
4	-1.9	-19.6	-1.2	3.0	4.2	9.3	11.5	20.5	18.6	6.3	-1.7	-7.1
5	-3.5	-18.2	2.6	2.6	3.2	11.9	11.7	24.2	18.3	9.9	2.2	-13.8
6	-2.6	-21.8	3.6	1.9	2.5	11.2	14.4	24.3	16.7	5.5	6.2	-16.6
7	-10.8	-18.6	2.8	3.3	6.1	9.8	20.8	26.7	16.1	4.3	2.9	-15.8
8	-10.6	-14.4	0.5	2.4	3.1	4.8	20.6	18.8	16.5	4.6	5.8	-14.4
9	0.1	-13.5	-8.0	0.3	1.4	10.0	15.0	14.4	19.2	6.7	-1.3	-21.5
10	-1.0	-6.7	-8.3	2.3	6.2	11.1	14.8	15.6	18.5	9.3	-5.0	-19.0
11	-13.0	-3.7	-8.3	2.5	7.5	18.3	23.2	16.7	12.1	9.5	-6.6	-6.4
12	-16.6	-2.7	-2.5	-0.4	7.4	16.1	23.1	18.6	10.0	4.0	-6.9	-10.2
13	-16.8	1.4	-0.3	1.3	11.8	18.9	22.7	18.2	7.1	3.7	-5.4	-12.1
14	-17.6	1.9	-1.7	-3.1	5.1	18.4	25.4	22.8	8.3	1.1	1.4	-8.0
15	-19.4	-0.3	-1.9	-5.1	0.9	15.2	20.4	19.8	8.1	0.9	1.9	-14.2
16	-14.2	1.5	-1.9	-8.2	1.6	12.7	20.4	21.1	11.6	8.1	-1.5	-19.7
17	-21.2	-3.4	-0.5	-9.4	5.1	11.8	23.3	21.0	7.8	2.8	-2.8	-23.8
18	-23.2	-7.2	-2.8	-7.3	11.5	13.2	22.1	21.8	13.0	0.8	1.5	-28.2
19	-16.7	-5.6	-6.8	-3.5	9.7	12.2	21.8	23.2	9.9	0.5	3.3	-27.8
20	-10.4	-2.6	-8.5	0.9	7.8	13.5	21.9	17.8	8.5	3.4	2.9	-24.5
21	-11.6	-3.5	-11.6	5.2	8.1	17.0	19.1	16.4	6.1	2.9	-1.8	-14.9
22	-9.7	0.4	-10.7	5.3	8.6	21.7	18.5	18.2	4.0	5.0	-2.8	-16.8
23	-2.4	-3.8	-11.1	4.5	12.2	21.2	20.0	18.6	5.9	4.2	2.4	-24.6
24	-8.2	-9.3	-12.6	4.4	6.1	21.3	19.4	17.4	7.2	6.3	-4.0	-22.2
25	-19.4	-12.2	-6.9	10.2	5.6	19.7	20.4	21.6	13.2	5.7	-5.7	-21.3
26	-20.2	-8.6	-1.9	5.9	6.0	15.9	20.8	23.4	14.1	5.7	-6.6	-13.0
27	-17.0	0.8	-0.9	5.2	7.2	10.8	23.1	22.8	10.3	10.3	-5.9	-16.1
28	-3.5	-7.3	-3.6	5.3	6.5	13.2	22.6	21.4	17.4	3.7	-4.3	-18.0
29	-0.1		-4.0	3.7	10.4	11.4	24.0	18.3	14.0	2.0	-5.2	-21.1
30	-6.5		-1.2	4.7	11.3	16.5	17.9	18.9	11.3	3.9	-6.3	-13.9
31	-12.9		1.4		11.5		19.9	19.1		5.1		-16.0

ANNUAL METEOROLOGICAL SUMMARY
SOMMAIRE MÉTÉOROLOGIQUE ANNUEL

for/pour THUNDER BAY "A", ONTARIO YEAR/ANNÉE: 1983

METEOROLOGICAL DATA FOR THE YEAR / DONNÉES MÉTÉOROLOGIQUE POUR L'ANNÉE

DAILY RAINFALL / CHUTES DE PLUTE QUOTIDIENNES

DATE	JAN JAN	FEB FEV	MAR MAR	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOÛT	SEPT SEP	OCT OCT	NOV NOV	DEC DEC
1				TR						2.2		
2						TR	5.4	15.6		7.2	TR	
3			0.4		TR	8.6	26.8	4.6	0.2	2.4		
4			0.6		TR	18.1	6.6		2.6	0.2		
5			1.2			0.8			4.6	2.3		
6			16.4			0.4				0.2		
7			13.6				0.2	14.8		6.3		
8			TR			5.2			0.7	TR		
9	2.4								7.7			
10	0.2			5.5		0.2		38.9	20.5	3.6		
11										13.7		
12					TR	TR				7.4		
13			0.2	0.2	0.4			TR	4.3	9.6	TR	
14		TR	TR		TR	1.3				0.8	0.3	
15						3.6			1.6	7.8	TR	
16		TR				0.4	5.6		5.4	1.0		
17					TR				0.3	0.2		
18					TR		0.4	TR	TR		TR	
19					0.9			12.6			9.6	
20		TR			4.4				0.6		30.5	
21								12.3	0.2			
22					11.2	2.1			0.4			
23	TR						0.4				32.2	
24					3.4			0.8		1.0		
25						10.1						
26						7.2		0.2		TR		
27		4.6					13.4	TR	0.4			
28	TR	0.2			10.6		0.8	TR	1.4	0.5	0.7	
29	1.4				11.1			8.2	17.1			
30			TR		5.9	9.9	TR		15.8			
31			0.3				2.8					

ANNUAL METEOROLOGICAL SUMMARY
SOMMAIRE MÉTÉOROLOGIQUE ANNUEL

for/pour THUNDER BAY "A", ONTARIO YEAR/ANNÉE: 1983

METEOROLOGICAL DATA FOR THE YEAR / DONNÉES MÉTÉOROLOGIQUE POUR L'ANNÉE

DAILY SNOWFALL / CHUTES DE NEIGE QUOTIDIENNES

DATE	JAN JAN	FEB FEV	MAR MAR	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOÛT	SEPT SEP	OCT OCT	NOV NOV	DEC DEC
1	2.0		TR	2.6								TR
2		TR	0.4									TR
3	0.4		3.8									0.2
4	1.4		TR									
5	TR	0.8										TR
6	3.3			TR								
7	TR			TR								
8			TR									0.2
9	1.7	1.9	4.1								2.6	
10	2.8	4.0		1.8								2.8
11		2.5									TR	20.4
12	3.4	TR										TR
13	2.6			13.8						1.3	2.0	6.6
14	4.6	TR	TR	20.6						7.0	0.2	0.2
15		TR		1.2								1.0
16	4.2		TR	0.2							TR	0.2
17	TR	0.2	2.0								TR	TR
18		5.2	0.6								TR	TR
19	0.4	10.4									0.4	
20		6.9									3.4	
21	TR	TR							TR		4.8	11.8
22									TR		3.3	1.6
23	TR	TR									4.6	TR
24	TR										TR	TR
25	TR											1.0
26											TR	TR
27	TR	0.8	TR								TR	
28	TR	0.4								TR	6.7	TR
29	10.4										2.6	TR
30	0.4		1.6								TR	
31	0.2		0.3									

ANNUAL METEOROLOGICAL SUMMARY
SOMMAIRE MÉTÉOROLOGIQUE ANNUEL

for/pour THUNDER BAY "A", ONTARIO YEAR/ANNÉE: 1983

METEOROLOGICAL DATA FOR THE YEAR / DONNÉES MÉTÉOROLOGIQUE POUR L'ANNÉE

TOTAL DAILY PRECIPITATION OF RAIN & SNOW / PRECIPITATION TOTALE DE PLUIE ET DE NEIGE

DATE	JAN JAN	FEB FEV	MAR MAR	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOÛT	SEPT SEP	OCT OCT	NOV NOV	DEC DEC
1	1.4		TR	2.8						2.2		TR
2		TR	0.4			TR	5.4	15.6		7.2	TR	TR
3	0.2		4.0		TR	8.6	26.8	4.6	0.2	2.4		0.2
4	0.8		0.6		TR	18.1	6.6		2.6	0.2		
5	TR	0.8	1.2			0.8			4.6	2.3		TR
6	3.2		16.4	TR		0.4				0.2		
7	TR		13.6	TR			0.2	14.8		6.3		
8			TR			5.2			0.7	TR		TR
9	4.1	1.6	1.9						7.7		2.5	
10	3.2	2.4		7.3		0.2		38.9	20.5	3.6		1.9
11		2.0								13.7	TR	19.4
12	1.4	TR			TR	TR				7.4		TR
13	2.6		0.2	16.7	0.4			TR	4.3	10.9	2.0	5.5
14	4.6	TR	TR	23.0	TR	1.3				7.8	0.5	TR
15		TR		1.0		3.6			1.6	7.8	TR	1.0
16	2.0	TR	TR	0.2		0.4	5.6		5.4	1.0	TR	0.2
17	TR	0.2	1.6		TR				0.3	0.2	TR	TR
18		4.5	0.2		TR		0.4	TR	TR		TR	TR
19	0.2	9.8			0.9			12.6			10.0	
20		6.9			4.4				0.6		33.9	
21	TR	TR						12.3	0.2		4.2	7.7
22					11.2	2.1			0.4		3.3	1.0
23	TR	TR					0.4				37.5	TR
24	TR				3.4	10.1		0.8		1.0	TR	TR
25	TR											0.8
26				5.0		7.2		0.2		TR	TR	TR
27	TR	5.4	TR				13.4	TR	0.4		TR	
28	TR	0.6		3.4	10.6		0.8	TR	1.4	0.5	7.2	TR
29	12.8				11.1			8.2	17.1		2.6	TR
30	0.4		1.4		5.9	9.9	TR		15.8		TR	
31	0.2		0.6				2.8					

ANNUAL METEOROLOGICAL SUMMARY
SOMMAIRE MÉTÉOROLOGIQUE ANNUEL

for/pour THUNDER BAY "A", ONTARIO YEAR/ANNÉE: 1983

MONTHLY AND ANNUAL EXTREMES OF RECORD / EXTRÊMES MENSUELLES ET ANNUELLES AUX REGISTRES

MONTH / MOIS	TEMPERATURE / TEMPÉRATURE								PRECIPITATION / PRÉCIPITATIONS					
	ABSOLUTE MAXIMUM ABSOLU	YEAR ANNÉE	ABSOLUTE MINIMUM ABSOLU	YEAR ANNÉE	HIGHEST MONTHLY MEAN MOYENNE MENSUELLE MAXIMALE	YEAR ANNÉE	LOWEST MONTHLY MEAN MOYENNE MENSUELLE MINIMALE	YEAR ANNÉE	GREATEST MONTHLY PRECIPITATION MENSUELLE MAXIMALE	YEAR ANNÉE	LEAST MONTHLY PRECIPITATION MENSUELLE MINIMALE	YEAR ANNÉE	GREATEST MONTHLY SNOWFALL NEIGE MENSUELLE MAXIMALE	YEAR ANNÉE
JAN/JAN	8.3	1942	-41.1	1951	-7.0	1944	-21.1	1982	143.3	1956	4.3	1944	143.3	1956
FEB/FEV	12.2	1976	-40.0	1970	-4.8	1981	-18.7	SVRL	81.0	1951	3.8	1978	70.4	1951
MAR/MAR	22.8	1946	-36.7	1943	-0.6	1973	-10.6	1943	102.9	1979	8.1	1969	87.6	1955
APR/AVR	28.3	1965	-22.2	1954	5.7	1955	-2.2	1950	136.9	1964	15.7	1944	79.2	1950
MAY/MAI	34.8	1980	-8.9	SVRL	12.0	1977	5.6	1967	174.2	1971	9.2	1976	34.8	1954
JUN/JUIN	35.6	1956	-2.8	1949	15.9	1955	10.9	1969	180.8	1944	30.5	1955	TR	1969
JUL/JUIL	37.2	1975	0.0	1969	19.7	SVRL	15.2	1965	200.3	1982	7.4	1981	0.0	
AUG/AOUT	40.3	1983	-1.1	1976	20.3	1983	13.6	1977	168.6	1977	27.0	1976	0.0	
SEPT/SEP	31.7	1976	-8.3	SVRL	13.7	1948	8.4	1974	284.2	1977	22.4	1952	1.5	1942
OCT/OCT	28.3	1943	-13.3	SVRL	10.5	1963	2.7	1976	166.6	1970	5.3	1947	22.6	SVRL
NOV/NOV	21.7	1975	-30.6	1976	0.7	SVRL	-7.6	1959	128.5	1958	7.9	1968	85.3	1950
DEC/DEC	12.2	1962	-37.8	1976	-5.4	1952	-17.2	1976	105.9	1948	10.4	1960	119.9	1968
YEAR ANNEE	40.3	Aug. 1983	-41.1	Jan. 1951	20.3	Aug. 1983	-21.1	Jan. 1982	284.2	Sept 1977	3.8	Feb. 1978	143.3	Jan. 1956

PERIOD OF RECORD/PERIOD DE REGISTRE 1941-1983

POOR

QUALITY

ORIGINAL